GALAPAGOS REPORT 2007 - 2008

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Foreword

Galapagos is experiencing rapid changes, requiring the best available tools to confront this reality. In 2005, we began to establish a common vision among the various local and regional organizations and groups involved in Galapagos. The hope is that this shared vision will help to create a better future based on a present understood and valued by all. The future of Galapagos does not solely depend on decision-making at the highest political and economic levels, but also on those of us who experience the islands daily and value their heritage.

The Galapagos Report was reinstituted in 2006, with the goal of providing an important tool for public policy development. The Galapagos Report 2007-2008 presents indicators across a wide spectrum that can and should be used by decision-makers and by the Galapagos community, to reach a social and environmental equilibrium. Only with regular monitoring throughout various areas of this social ecosystem can we truly measure our path forward.

Galapagos is unique, due to its natural and social communities and the interaction between the two. Its sustainability depends upon forging a shared vision sustained by interinstitutional collaboration and decision-making based on technical data. This document is another step toward this global goal.

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In addition, the articles presented here are the result of contributions from many people and institutions, including: Public Prosecutor's Office of Santa Cruz, Santa Cruz County Board for the Protection of Rights, Environmental Police, Galapagos Chamber of Tourism (CAPTURGAL), Association of Tourism Operators of Galapagos (ADATUR), Santa Cruz Fire Department, Civil Aviation Directorate (DAC), Provincial Office of Education, National Institute of Statistics and Censuses (INEC), Ministry of Tourism, and municipal governments; various tourist and dive operators and agencies; directors and members of the fishing cooperatives of Galapagos, and members of the Galapagos community who participated in opinion surveys.

The report was improved with artistic contributions by Alejandra Badillo, Alex Hearn, Andrés Marchant, Cristina López, Daniela Chalén, Diego Añazco, Frank Bungartz, Jason Heilmann, Joaquín Carrasco, Jorge Sotomayor, Mandy Trueman, Paola Sotomayor, Pepe Navarro, Ricardo Fernández, Tom Poulsom, and Verónica Toral, all of whom provided the photographs used in this edition.

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Introduction

Socioeconomic Issues

Biodiversity and Biophysical Resources

Toward a shared vision of Galapagos: the archipelago as a socioecological system

Washington Tapia[1], Pablo Ospina[2], Diego Quiroga[3], Günther Reck[3], José A. González[4], Carlos Montes[4], Eliécer Cruz[5], Brian Milstead[6], Matthias Wolff[6], Graham Watkins[6], Carlos Carrión[1], Mario Piu[1] & Marco Oviedo[7]

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"In moments of crisis imagination is more important than knowledge."
Albert Einstein

Galapagos at a crossroads

Galapagos under threat, Galapagos in crisis, Galapagos at risk! In recent years we have become accustomed to reading, relatively frequently, this type of headline in the popular press, as well as in scientific articles, evaluations of the conservation status of Galapagos carried out by international organizations, and even in an executive decree of the Ecuadorian government.

What is happening? How is it possible that we have arrived at such a situation in Galapagos—one of the most legally protected places on the planet and where increasing amounts of human, technical, and financial resources have been invested in recent years?

There is no question that we must preserve Galapagos. That is the intent of current governmental policies, laws, and planning efforts. However, in spite of the notable conservation efforts of recent years, a shared vision of how and why we should conserve Galapagos does not exist. While most stakeholders envision conservation and sustainable development as the ultimate goal of their activities, each one acts according to their own vision of what the archipelago is and what it means to the local population, Ecuador, and the world. Efforts to build consensus among stakeholders have been

made, but they have not addressed the deep differences in opinion that exist and the reasons for these differences.

The result is that the archipelago continues to be enveloped in a profound socioecological crisis, reflected in the exponential growth of critical variables (population, number of tourists, exotic species, number of vehicles, energy consumption, etc.) that threaten its sustainability. The recent decision of UNESCO to declare Galapagos a World Heritage in danger underscores the current critical situation.

Rather than as a potential catastrophe, the current situation should be seen as a "window of opportunity" to learn from past mistakes and to break the resistance to change. Recognizing that a problem exists is the first step in any transformation process. In this sense the current situation can be a true opportunity, perhaps the last, to reorient the system towards a more sustainable model.

In 2007, the Ecuadorian government publicly recognized the profound changes needed in Galapagos when it declared Galapagos at risk and its conservation and the environmental management of the archipelago a national priority. But the question remains: What do we change? The Management Plan of the Galapagos National Park (GNP) recognizes that an enormous effort has been invested in the last three decades to attack the effects and not the real causes of problems (GNP, 2005). To be able to effectively change the current path of Galapagos we must look at the archipelago from a different perspective, one that will permit the identification of the real causes of the crisis.

In 2007 and 2008, the GNP initiated an interdisciplinary and participatory research project to develop a socioecological model for the archipelago that would provide the foundation for the development of the kind of shared vision called for by various regional planning documents. Key to the success of this project will be the clear identification of the primary causes of current problems and the willingness to confront the crisis. Some of the results of the project are presented here. The objective of this article is to provide a theoretical and conceptual basis for future work and to stimulate debate over which management model is most applicable to the archipelago.

Galapagos as a system: everything is interrelated

Simply put, a system is an entity formed by interdependent units that function as a whole. In addition, systems have emerging properties that arise from the interactions of their components. From a system-based perspective, the "whole" is much more than the sum of its parts. As such, a system cannot be understood nor managed efficiently if the flow of energy, materials, and information that connect and bind together the different components is unknown and unmanaged. Except for a few recent attempts to analyze the problems of Galapagos from an integrated perspective (MacFarland and Cifuentes, 1996; GNP, 2006; Watkins and Cruz, 2007; González et al., 2007), the predominant perspectives of the archipelago have been sector-based rather than system-based.

In Galapagos, the different components of the system are tightly linked and interconnected by biophysical, economic, and sociocultural flows that operate at different levels (Figure 1). The principal flows entering the system on a national level are materials and energy from the continent, as well as people and exotic species. On an international level there are notable financial and information inflows, which are important when defining and explaining the current lifestyle of Galapagos residents.

In terms of outflows from Galapagos, there are enormous financial flows from the islands on both the national and international levels, as well as information outflows related to the scientific value of Galapagos.

The following diagram depicts Galapagos as an open system, dependent on the outside world. The archipelago appears as an importer of human capital, energy, and materials, and as an exporter of financial capital and information through tourism and science. It also

shows Galapagos as a very fragile system given its elevated dependence on the outside world. This vulnerability is particularly worrying in the context of global change [1]. It is clear that solutions to current problems in Galapagos must be found at various levels.

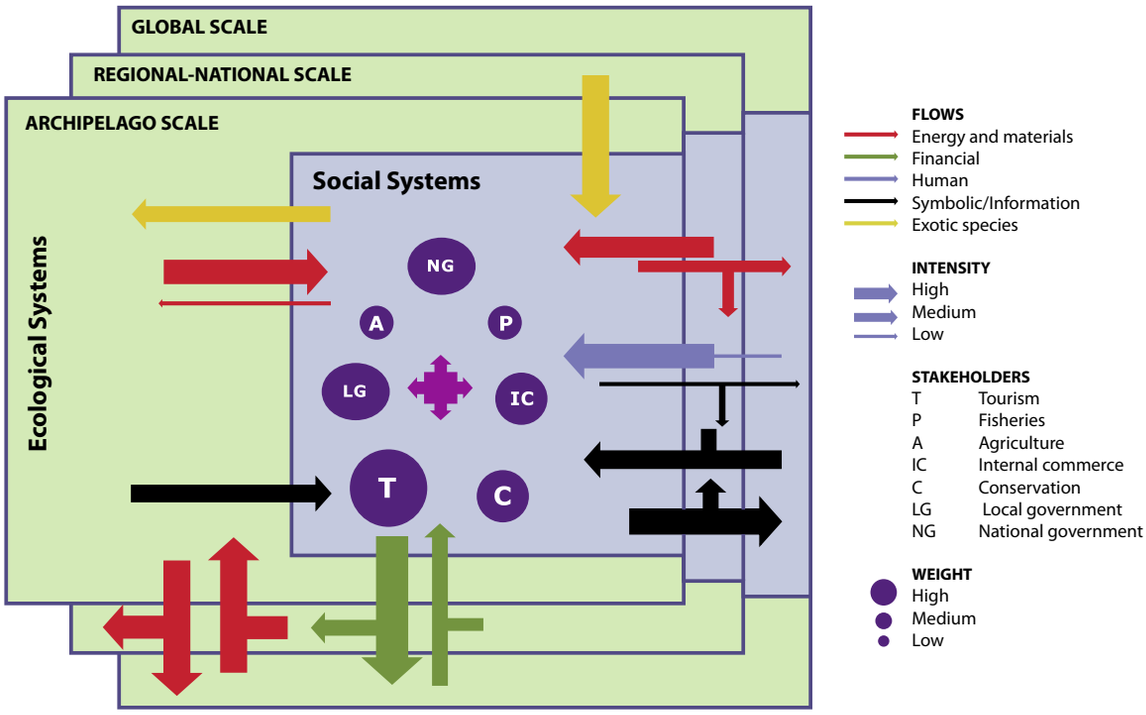


Figure 1. Depiction of the archipelago as an open system that is highly vulnerable to disturbances, primarily from the outside world.

Maintaining the ecological and evolutionary processes of Galapagos and its biodiversity and unique ecosystems is highly dependent upon the isolation that has characterized the archipelago during most of its history (Bensted-Smith, 2002). However, the human population that lives in the islands demands an increasing flow of goods and services from outside the system, thus increasing its vulnerability. Ensuring the coexistence of species and ecosystems of the archipelago with human society is not an easy task (Ospina, 2006).

Galapagos as a socioecological system: ecosystems and human welfare

One of the elements that may help explain why policies to promote sustainability in Galapagos have been largely unsuccessful is the belief held among many that human society and nature conservation are not sufficiently linked so as to require integrated management. The prevailing view has been that nature and society can be administered more or less independently from one another and, as long as both camps demonstrate mutual respect, a balance can be struck between conservation and development.

Galapagos is profoundly anchored in and inseparable from the insular and marine ecosystems with which they interact and depend.

Reality shows that the socioeconomic system of Galapagos is profoundly

1 Emerging process related to environmental changes generated by human activity that are modifying essential biogeophysical processes that determine the functioning of our planet (Duarte, 2006).

anchored in and inseparable from the insular and marine ecosystems with which they interact and depend. The social systems are part of an even larger system; they exist and function as part of a socio-ecological system or socioecosystem.

From this perspective, ecosystems and society should be conceptualized and managed as a single, integrated unit. This form of thinking and acting will help to break down the artificial barrier that has existed between conservation and development. It will focus interventions on the management of the interrelationships and processes that link the human and natural systems, rather than on separate components of the system.

The conceptual model developed to understand Galapagos as a socioecological system (Figure 2) highlights the tight, bi-directional links that exist between the social system and natural capital. Natural capital is understood as insular and marine ecosystems that maintain their ecological integrity (structure, dynamics, functioning, and capacity for self-organization) and which are jointly capable of generating a combination of essential services for human development at distinct spatial (regional, national, and international) and temporal (present and future) scales.

The ecological integrity of the natural system depends largely on the conservation of the structure and functioning of the insular and marine ecosystems of the archipelago. These, in turn, depend on biodiversity and the maintenance of evolutionary potential and essential ecological processes such as primary production, the water cycle, nutrient cycles, and ocean current systems.

The dynamics of the social system are sustained through diverse cultural, socio-political, and economic processes driven by a series of actors that interact with one another and with the natural system in complex ways. These interactions are governed by relationships that are partially independent from the functioning of ecosystems, such as balance of power among stakeholders, the interplay between material interests, and the cultural environment in which they take place.

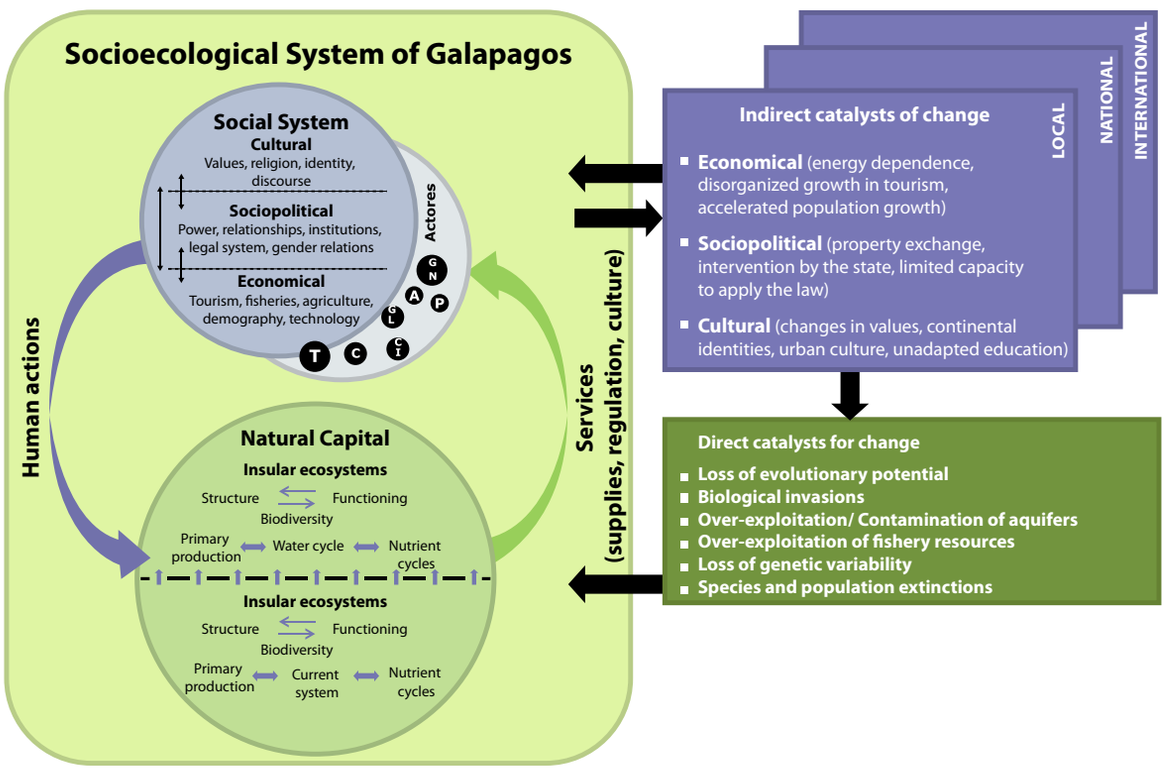


Figure 2. Viewing Galapagos as a socioecological system permits an understanding of the dependent relationships between the social system and insular and marine ecosystems, and helps to identify the real causes of current problems.

Changing paradigms: a new form of thinking and acting

The rapid and intense changes that Galapagos has experienced in recent years have divided the islands into two camps: conservation and development. Management of the protected areas has tried to minimize the impacts of human activities that could affect natural ecosystems. This has created an opening for various processes and socioecological relationships, pitting protected areas against inhabited zones.

We now know that this approach will not conserve the ecosystems and biodiversity of Galapagos. No matter how much one expands the limits of the protected areas, social interactions and indirect catalysts will continue to affect them because those who live in Galapagos depend on the protected areas and will continue to use, change, or alter them. At the same time, certain biogeophysical processes that are essential for the ecological integrity and the resilience of Galapagos ecosystems strongly depend on areas located outside the protected areas.

To analyze the current situation of the archipelago and be able to design innovative management models that will reverse current trends and solve the present crisis, it is imperative to understand and look at Galapagos differently. The local population must be considered part of this complex socioecological system, a system whose primary processes (primary production, water cycle, nutrient cycles, current systems, etc.) must be maintained if Galapagos biodiversity is to be conserved and social welfare enhanced.

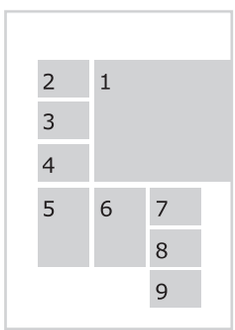
Analysis of the principal catalysts of change, those that influence the dynamics of the system and represent the root cause of the present crisis, clearly shows that current problems are not rooted in the natural system but rather in the socioeconomic and cultural systems.

Tourism provides a good example of the complex and dynamic socioeconomic interactions now underway in Galapagos. Various studies have highlighted the fact that tourism is the principal economic activity in the archipelago, driving, catalyzing, and determining the dynamics of the rest. Tourism drives immigration and is the principal factor opening the province to the outside. Although tourism produces certain direct impacts on the natural system (waste and pollution, among others), its principal impacts are indirect and affect the entire socioecological system through an economic model based on unlimited growth, increasing consumption, and the accumulation of material wealth.

To reorient Galapagos toward truly sustainable models of development, management policies should focus on changing the current nature of the local economy. They should address the internal balance of power and relationships with external economic interests. The strength of the current cultural, economic, and political power bases make it difficult to develop a shared vision of the future of Galapagos.

It is clear that the ecological systems in Galapagos require urgent and innovative measures to be able to adapt to disturbances and changes produced by human activities and the progressive loss of geographic isolation. One of those measures is an explicit recognition in planning and management that the social systems in Galapagos are a dynamic and influential force and that they must be evaluated and restructured. If intellectual, social, and cultural capital are not systematically identified and engaged in long-term management objectives, a progressive loss of the natural capital of Galapagos will ensue. This loss in biodiversity will have profound effects on the quality of life in Galapagos with inevitable and irreversible consequences.

Socioeconomic Issues



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Sexual abuse of children: an emerging social problem in Galapagos [1]

Roberto Maldonado

National Institute of Children and Families - INNFA

Sustainable development exists when economic growth is accompanied by rational use of resources and enforcement of human rights. It is unsound to evaluate conditions or discuss the future of Galapagos while taking into account only one or two of these pre-conditions. It is imperative that economic development be carried out in a way that is consistent with the unique environment of the islands and that it is accompanied by an honest and timely attention to the wellbeing of Galapagos society.

According to national statistics related to poverty and access to education and health services, etc., the standard of living in Galapagos is one of the highest in Ecuador. In addition, Galapagos is the province where rights of children and adolescents are most highly protected (Observatorio de los Derechos de la Niñez y la Adolescencia; UNICEF, 2006.). That being said, an urgent hidden problem exists in the islands, one not found in the statistics: sexual abuse of children.

Sexual abuse of children and adolescents is frequently concealed or denied, and is often invisible to society. Using coercion or intimidation, aggressors silence their victims, who often refuse to denounce their abusers. The consequences of sexual abuse are serious; the effects of the aggression are deepened when the victims are stigmatized, rejected, or misunderstood. For this reason, attention to child and adolescent victims must be timely and integrated. Emergency treatment must include medical, psychological, social, and legal attention.

Although Galapagos may have fewer problems than continental Ecuador, the worst case of sexual abuse against Ecuadorian children occurred in the archipelago. In 2003 the criminal acts perpetrated by the Burdett Cedeño couple were publicly exposed. Over a period of several years these individuals committed acts of rape, child pornography, illegal administering of drugs, and corruption of minors, which may have affected hundreds of children from the province and other parts of Ecuador. To date there have been

1 This article was researched and written with the collaboration of technicians of the Decentralized Territorial Unit of the National Institute of Children and Families (INNFA) in Galapagos.

Photograph: Diego Añazco

16 court cases, nine of which ended with sentences ranging from 12 to 25 years. If these sentences were served consecutively, these criminals would remain in prison for the next 196 years. However, Ecuadorian law does not allow for consecutive sentencing, so their total incarceration will be 25 years.

Sexual abuse of children and adolescents is frequently concealed or denied, and is often invisible to society.

The serious nature and magnitude of the Burdett Cedeño case provided the catalyst for legal reforms to establish harsher sentences for criminals and to define other types of offenses such as physical abuse and sexual exploitation. Currently no case of sexual abuse in the islands approaches the magnitude of the Burdett Cedeño cases. However, the data show that far from disappearing, the number of reported incidents has actually increased.

Our analysis focused on Santa Cruz because of the availability of information. The data show that the number of cases of child sexual abuse reported in the last four years has increased. This increase may have two explanations: more victims are now deciding to accuse their aggressors or there are simply more cases.

Both national and international legislation[2] state that children and adolescents have the right to be protected from all types of sexual abuse and exploitation. The difference between these two offenses is that sexual exploitation implies an economic benefit to the aggressor while sexual abuse does not. Sexual exploitation includes prostitution and child pornography.

Article 206 of the Code for Childhood and Adolescence (CCA) states that each canton or county should have a functioning County Board for the Protection of the

2 The principal legal bodies that are currently applicable include the Convention on the Rights of the Child adopted in 1989 by the General Assembly of the United Nations and the national Children and Adolescents Code of 2003.

Rights of Children and Adolescents (CBPR) responsible for "looking into cases of threats to or violation of the rights of children and adolescents within their jurisdiction and carrying out the measures necessary to protect the threatened rights or restore violated rights." Santa Cruz has a population of 3921 people under 18 years old (INEC, 2006). Between 2005 and 2007, the CBPR of Santa Cruz received 358 reports of violations of the rights of children and adolescents. The most common offense is physical abuse followed by negligence (Table 1). On an international level, reported sexual offenses tend to be statistically low (Save the Children, 1998), with an estimate that only 20% of abuses against women and 10% of abuses against men are actually reported. The rest of the victims continue to live their abuse in silence.

Table 1. Cases received by the County Board for the Protection of Rights of Children and Adolescents of Santa Cruz between 2005 and 2007[3].

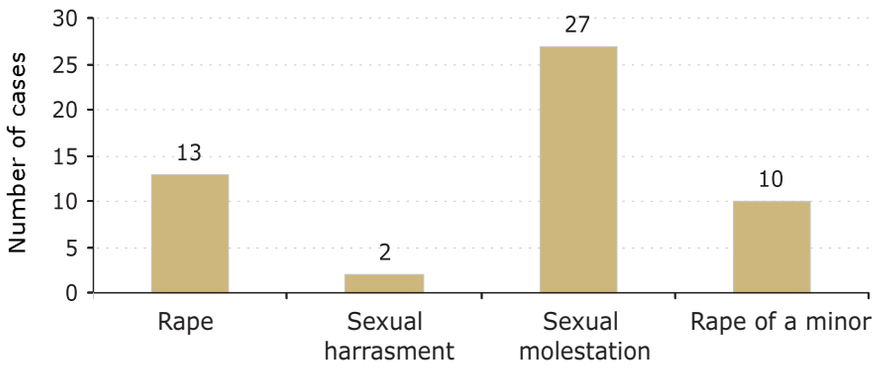
	Physical Abuse	Negligence	Sexual offenses	Others	Total
2005	*9*	*12*	*2*	*1*	*24*
2006	*55*	*41*	*8*	*24*	*128*
2007	*60*	*52*	*21*	*73*	*206*
Total	**124**	**105**	**31**	**98**	**358**

Source: CBPR of Santa Cruz.

Judicial procedure requires that the District Attorney be informed of all cases of sexual abuse or offense, resulting in a higher total number of offenses than the number received by the CBPR. The District Attorney of Santa Cruz has received notification of 50 cases of sexual offenses in the last three years: 13 in 2005, 13 in 2006, and 24 in 2007. However, between August and December 2005, the record does not provide details of types of cases so there may be more cases of sexual abuse in that year.

The National Institute for Children and Families (INNFA) has a technical team to respond to cases of physical abuse, negligence, and sexual abuse through social, legal, and psychological assistance for victims and their families. From 2005 through the first three months of 2008, this team responded to 52 cases. Of these, sexual molestation was the most frequent (27 cases), followed by rape (13 cases), and rape of minors (10 cases) (Figure 1).

Figure 1. Cases responded to by INNFA between 2005 and 2007[4].



Source: INNFA.

3 Mistreatment includes physical, psychological, and institutional acts against children and adolescents. Negligence is the act or omission of acts that result in the violation of the rights of children and adolescents. Sexual offenses include rape, sexual molestation, rape of minors, sexual harassment, and sexual exploitation.

4 The types of crimes are those established by the current Criminal Code.

In terms of age of victims, 50.9% are younger than 12 years, 7% are under six years, and 49.1% are between 12 and 17 years old. Clearly, sexual offenses affect victims of all ages.

Of all sexual offenses reported, 81.8% of the victims are female. Males represent 18.2% of the victims who have reported offenses and all are under 15 years old. The low incidence of reports of abuse among young males may reflect a greater tendency to hide the abuse due to myths and prejudices regarding masculinity (for example the fear that they will be marked as homosexuals).

On the other hand, most reported aggressors are male and are well-known to the victim. In 95% of the cases, the relationship with the victim was that of friend, neighbor, teacher, or boyfriend and the violation occurred within the daily environment of the child.

Galapagos falls under the legal jurisdiction of the Province of Guayas. This requires that both victims and witnesses travel to Guayaquil for legal proceedings. The cost of traveling to the mainland combined with court summons that do not always specify a date and time, often make it difficult to appear in court and increase the risk that the criminals go unpunished. For this reason, one of the most important steps needed to reestablish the rights of children and adolescents in the archipelago is to establish a Criminal Tribunal and court specialized in the rights of children and adolescents in Galapagos.

We must be aware of what is occurring in Galapagos, given that sexual abuse against children and adolescents is a very serious crime and unfortunately something that many children and adolescents in our community are experiencing. This crime affects children during their formative years making this more than just an ethical and moral offense; it is also a factor that negatively affects the communities.

Providing children and adolescents a healthy environment that allows them to grow and develop healthy, safe, and happy should be a priority. To achieve this, those of us who live in the islands must understand what is happening around us. We must ensure that the necessary steps are taken to prevent these types of crime from occurring. The institutions established to protect the rights of children and adolescents, judicial authorities, and both public and private institutions in Galapagos must truly and without discussion assume the responsibility for the interests of children established in Article 11 of the Code for Children and Adolescents in all of their decisions and in the development of their annual plans and programs and the design of public policies.

4 The types of crimes are those established by the current Criminal Code.

A Galapagos identity

Hugo Barber[1] **& Pablo Ospina**[2]

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2 Universidad Andina Simón Bolívar

The literature describing the social situation in Galapagos often mentions that to achieve lasting conservation of the islands requires the commitment of the inhabitants. This commitment comes from a strong sense of island "identity" and a lifestyle that is consistent with the ecological importance and fragility of the archipelago. Such an identity and lifestyle would include respect for the unique ecological value of the islands, for efforts to preserve their physical isolation, and for the environmental laws and regulations of Galapagos.

This article explores the following question: Do Galapagos residents with a greater appreciation for or emotional attachment to the archipelago (aka "Galapagos Identity") also show a greater acceptance of environmental restrictions associated with living in the province? We begin with a brief review of how we approached the concept of Galapagos identity through a public opinion survey carried out in June 2006 and March 2008 (Table 1) and focus groups[1] involving inhabitants on each of the three most populated islands of the archipelago. We then present a statistical analysis to show the relationship between Galapagos identity and the acceptance of environmental restrictions associated with living in Galapagos.

Table 1. Public opinion surveys carried out in Galápagos.

	1997	1998	1999	2000	2001	2006	2008
Survey month	July	October	September	January	November 2000	June	March
Total No. Surveys	377	427	582	553	573	442	487
Isabela	102	109	160	150	151	102	104
San Cristóbal	147	158	209	203	213	147	185
Santa Cruz	128	160	213	200	209	193	198
Standard Error	±5.2	±4.8	±4.1	±4.3	±4.2	±4.7	±4.5

Sources: Falconí (2002: 53); Barber and Ospina (2006), and Opinion Survey of March 2008.

1 A focus group is a type of collective interview, generally with a group of people with relatively homogeneous social characteristics. The four focus groups that were used in this study had five to nine people; the length of the interviews ranged from two to three hours.

Association with a Galapagos identity

A practical way to describe "Galapagos identity"[2] is to ask residents to attach a value to qualities describing Galapagueños (defined as natives or those who have lived in the islands for an extended period of time) and then compare the values with those they assign to Ecuadorians in general.[3] Those qualities for which a higher value is given to Galapagos residents would be more closely associated with a Galapagos identity. The result of this exercise is that for almost all of the qualities listed, respondents gave a higher average value to Galapagueños than to the rest of Ecuadorians. One exception was in response to qualities related to "laziness vs. industriousness," where there were no statistically significant differences (Table 2). Those qualities most closely associated with Galapagueños include "tranquility," "love for the islands," "caring for the islands," and "honesty." Survey participants appear to agree with the idea that Galapagueños have a greater inclination to care for the environment.

Table 2. Values associated with Galapagueños versus other Ecuadorians (2008 survey).*

NEGATIVE – POSITIVE	2006 (June)		2008 (March)	
	Ecuadorians	Galapagueños	Ecuadorians	Galapagueños
Closed – Open	3.72	3.93	3.63	3.89
Selfish – Generous	3.24	3.70	3.48	3.71
Lazy – Industrious	3.79	3.58	3.55	3.53
Aggressive – Tranquil	3.07	3.62	3.29	3.80
Hypocritical – Sincere	3.25	3.35	3.06	3.29
Irresponsible – Responsible	3.44	3.43	3.35	3.54
No concern for the islands - Love for the islands	3.39	3.86	3.51	4.05
Don't care for the environment – Care for the environment	3.32	3.65	3.23	3.83
Unfriendly – Friendly	3.67	3.94	3.77	4.09
Corrupt – Honest	2.61	3.22	2.79	3.33
Conflictive – Not conflictive	2.77	3.07	2.92	3.32
Disagreeable – Genial	3.48	3.60	3.33	3.66
AVERAGE	**3.31**	**3.58**	**3.33**	**3.67**

Sources: Opinion Surveys of June 2006 and March 2008, carried out in Galapagos.

*Note: Data weighted according to the population of each island; the higher the value, the more positive the opinion.

The surveys and focus groups both indicated that Galapagueños have a strong affinity with life in the islands and consider themselves to possess more positive values than their compatriots on the mainland. However, to develop a better understanding of local opinion related to characteristics associated with Galapagos identity, the survey included a series of additional questions (Table 3).

Although almost 75% of the people interviewed expressed a desire to live in Galapagos all of their lives and 45% think that Galapagueños should enjoy more rights than others, about 60% think there is too much selfishness in Galapagos, and 79% think that they cannot confide in others due to gossip (Table 3). This reveals that while most residents value living in Galapagos, they may have a

2 No standard definition of "Galapagos identity" exists. In this study, it is defined as the combination of attributes that are associated with being a Galapagueño.

3 Survey participants were asked to respond to the following question: "On this sheet you will see a series of positive and negative characteristics. On each line, you must mark with an 'X' the space that you think most appropriate." (…) "We understand "Galapagueño" to mean both natives and those who have lived in the islands for a long time…" The same approach was used to obtain their opinions about other Ecuadorians.

negative view of social interactions among Galapagueños. Although not stated in the survey, reasons for valuing "living in Galapagos" are apparently related to values such as tranquility, the beauty of the surroundings, and certain favorable conditions of comfort and employment.

Table 3. Percent agreement or disagreement with phrases that value coexistence in Galapagos, March 2008.

PHRASE	Disagree strongly	Disagree	Neither agree nor disagree	Agree	Agree strongly
Here in Galapagos everyone thinks only of themselves and no one is concerned for others.	3.1	26.9	14.8	47.0	8.2
I want to live in Galapagos all of my life.	0.8	12.5	11.3	41.2	32.4
Here people gossip, so you cannot trust them.	0.5	9.6	10.2	51.6	27.3
Galapagueños should have more rights than others.	5.0	32.4	15.6	37.6	8.0
In Galapagos one must learn to defend oneself against the selfishness of neighbors.	4.6	20.0	13.8	53.3	7.6

Note: Data weighted according to the population of each island.

Galapagos identity and acceptance of environmental restrictions

While living in Galapagos carries with it many advantages, it also requires accepting a variety of environmental restrictions. Having established some of the values associated with a Galapagos identity and the strong attachment of Galapagos residents to the islands, we can begin to examine the relationship between the strength of association with this identity and the acceptance of the environmental restrictions that are necessary to protect the insular ecosystems and to determine to what extent people are willing to accept both personal and social sacrifices for the betterment of Galapagos.

Our study is based on several assumptions. First we assume that those Galapagueños who believe there are more positive qualities among residents of the archipelago and those who express a more positive view of social interactions among Galapagueños have a greater association with the "Galapagos identity." Another assumption is that Galapagos identity is also associated with time spent living in the islands. Our qualitative analysis confirms what has been revealed in previous studies: that there is a generalized belief in Galapagos that those who live more time in the islands have a greater attachment to the archipelago and have the right to enjoy certain privileges.

On the basis of these assumptions, we examined Galapagos identity according to three distinct criteria: (i) level of association with the Galapagos identity in comparison with continental Ecuadorians; (ii) appraisal of social interactions among Galapagos residents; and (iii) time living in the province.

In a number of areas, those who most value the qualities of the Galapagos identity are not those with the greatest acceptance of environmental restrictions (Table 4). For example, this group tends to believe that the problem of introduced species has been exaggerated, that the government is more interested in Galapagos wildlife than in human beings, and that there should not be an established limit to the number of tourists. There is also a greater percentage among this group who think that environmental protection is only a "pretext" for various environmental restrictions. On the other hand, this group is less inclined to believe that the Special Law for Galapagos harms residents or that they should be able to import produce and other products without restrictions (Tables 4 and 5). They are also more strongly opposed to immigration and accept restrictions for their own families. However, a comparison among the three groups reveals relatively small differences.

Table 4. Survey results (% subgroup in agreement) based on Criteria 1 - level of association with the Galapagos identity.

PHRASE	Level of association with the Galapagos identity*		
	Low	Medium	High
Immigration increases unemployment levels	76.3	72.0	79.4
Shark fishing should be allowed	9.5	17.7	12.1
Bringing all types of fruits and vegetables from the continent should be allowed because they are cheaper	59.6	60.7	53.7
Closed fishing seasons are beneficial to fishermen	60.7	69.1	59.0
Immigration increases delinquency levels	77.8	82.9	82.1
Eliminating animals that live in the street is fine	83.8	82.6	81.5
The more people that live in the islands, the greater the environmental damage	82.8	80.3	88.6
The government is more interested in the wildlife in Galapagos than in human beings	48.5	54.8	59.5
The Special Law for Galapagos is harmful to residents and Galapagueños	35.0	24.6	22.9
The problem of introduced species is exaggerated	52.9	54.9	57.7
Harvesting native timber should be allowed	16.8	14.3	9.0
If my relatives want to come and live in Galapagos, they should be able to do so since this is also their country	40.0	44.2	35.4
There must be a limit to the number of tourists	32.6	31.8	27.8
In Galapagos all is prohibited on the grounds of protecting the environment	70.8	72.9	79.1
The Special Law for Galapagos is good for conservation of nature	72.7	73.0	82.7
The protected areas of Galapagos are too large	57.5	67.5	56.9
I would be willing to pay more for water to finance treatment for pollutants	52.9	50.6	55.2

Source: Opinion Survey of March 2008.
Note: Data weighted according to population of each island.
* "Low" refers to the subgroup of survey respondents who rated the average qualities of Galapagueños lower than those of continental Ecuadorians; "High" refers to the subgroup that rated Galapagueños above continental Ecuadorians.

Table 5. Survey results (% subgroup in agreement) based on Criteria 2 - extent to which residents positively value social interactions in Galapagos.

PHRASE	Level of positive appraisal of social interactions in Galapagos*		
	Low	Medium	High
Immigration increases unemployment levels	74.1	78.7	75.5
Shark fishing should be allowed	10.4	13.1	15.4
Bringing all types of fruits and vegetables from the continent should be allowed because they are cheaper	59.5	65.3	47.2
Closed fishing seasons are beneficial to fishermen	55.1	62.3	72.3
Immigration increases delinquency levels	76.6	83.2	82.6
Eliminating animals that live in the street is fine	82.1	85.0	80.4
The more people that live in the islands, the greater the environmental damage	81.9	85.3	84.9
The government is more interested in the wildlife in Galapagos than in human beings	51.5	53.5	58.2
The Special Law for Galapagos is harmful to residents and Galapagueños	32.7	26.5	23.2
The problem of introduced species is exaggerated	53.2	63.4	47.6
Harvesting native timber should be allowed	6.9	15.1	18.8
If my relatives want to come and live in Galapagos, they should be able to do so since this is also their country	38.4	39.0	42.7
There must be a limit to the number of tourists	29.0	25.1	39.5
In Galapagos all is prohibited on the grounds of protecting the environment	77.8	77.3	66.9
The Special Law for Galapagos is good for conservation of nature	70.8	83.2	74.0
The protected areas of Galapagos are too large	60.4	59.9	60.9
I would be willing to pay more for water to finance treatment for pollutants	50.4	49.5	59.8

Source: Opinion Survey of March 2008
Note: Data weighted according to population of each island.
* "Low" refers to the subgroup of survey respondents who consider that social interactions in Galapagos are noted for selfishness and gossip and who do not enjoy them; "High" refers to the subgroup that values the social interactions in Galapagos.

Those Galapagueños who view social interactions in Galapagos positively appear to be slightly higher in their acceptance of environmental restrictions, with three exceptions: there is less acceptance of the prohibition of shark fishing, restrictions on harvesting timber, and limits to immigration by family members (their responses to immigration were similar to those who had lived longer in Galapagos). In practically all other areas, this group supports environmental restrictions including a limit on the number of tourists, quarantine restrictions, and a higher fee for water to finance water treatment, and they do not share the opinion that the Special Law for Galapagos harms residents. In general, the opinions of those considered to have a high appraisal of Galapagos identity based on their opinion of social interactions differed greatly from those who rated the Galapagos identity above continental Ecuadorians.

As was the case with the previous two criteria, it is not always true that the residents who have lived longer in Galapagos are more likely to accept environmental restrictions (Table 6). Those who were born in the islands tend to have a more unfavorable opinion of restrictions in almost all cases. Although they are more likely to accept closures of specific fisheries, they are also more likely to believe that shark fishing should be permitted. Although they tend to agree with restrictions on the importation of fruits and vegetables, they are also more likely to believe that the problem of introduced species has been exaggerated. Although they tend to oppose immigration, they believe that their own relatives should be able to come to the islands without restrictions. More members of this group believe that they should be able to harvest native timber and that the protected areas in the province are too large. One notable difference between recent immigrants and natives is their attitude towards tourism. Among natives, 41% believe that there should be a limit to the number of tourists, while only 23% of recent immigrants agree with this view.

Table 6. Survey results (% subgroup in agreement) based on Criteria 3: time lived in Galapagos.

PHRASE	Time in Galapagos*		
	Less	More	Born in GPS
Immigration increases unemployment levels	73.7	79.3	71.0
Shark fishing should be allowed	3.6	13.2	21.3
Bringing all types of fruits and vegetables from the continent should be allowed because they are cheaper	62.5	57.2	54.9
Closed fishing seasons are beneficial to fishermen	52.9	61.9	74.6
Immigration increases delinquency levels	76.5	82.5	80.6
Eliminating animals that live in the street is fine	76.4	85.2	82.5
The more people that live in the islands, the greater the environmental damage	78.6	85.4	86.1
The government is more interested in the wildlife in Galapagos than in human beings	51.6	54.0	57.1
The Special Law for Galapagos is harmful to residents and Galapagueños	27.5	28.1	26.7
The problem of introduced species is exaggerated	48.7	57.5	56.2
Harvesting native timber should be allowed	11.9	12.3	17.7
If my relatives want to come and live in Galapagos, they should be able to do so since this is also their country	36.5	40.0	40.2
There must be a limit to the number of tourists	22.6	29.7	41.4
In Galapagos all is prohibited on the grounds of protecting the environment	77.4	73.6	73.2
The Special Law for Galapagos is good for conservation of nature	68.6	78.9	77.1
The protected areas of Galapagos are too large	56.8	60.7	63.0
I would be willing to pay more for water to finance treatment for pollutants	52.3	52.9	53.4

Source: Opinion Survey of March 2008
Note: Data weighted according to population of each island.
* "Less" refers to the subgroup of survey respondents who have lived in Galapagos for less than one third of their life; "More" refers to the subgroup that has lived in Galapagos more than one third of their life.

Photograph: Alejandra Badillo

Conclusions

The general conclusion of this study is that greater attachment to a Galapagos identity—regardless of which of the three criteria is used--is not clearly associated with a greater acceptance of environmental restrictions associated with life in Galapagos. Of the three, time living in the islands appears to have the greatest effect. Even so, the most significant differences are apparent in views towards fishing and tourism (closed fishing seasons, shark fishing, and limiting the number of tourists). It is possible that the differences are not based on the time living in Galapagos but on other variables, such as island of residence, socioeconomic level, and profession.

To date the studies of Galapagos identity have been based exclusively on qualitative research. The questions asked in the surveys of June 2006 and March 2008 permit a new type of quantitative approximation that may complement previous analyses. It is possible to perform statistical tests, create profiles of attitudes regarding Galapagos identity, and study these profiles according to income, socioeconomic activity, level of community involvement, and educational level. The study also points to the need to analyze in greater detail the relationship between time living in the islands and appraisal of social interactions, as these variables may be interrelated.

The current status of the educational system in Galapagos

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"A population with a high level of education and training constitutes the first ally for the conservation of Galapagos."

The Special Law for Galapagos of 1998 calls for an Integrated Educational Reform for Galapagos (IERG) and a special model of education and training that involves the participation of the local community and takes into account the special needs and conditions in the archipelago. The IERG is currently being developed by the Provincial Directorate of Education (PDE) and has the support of the Ministry of Education, which incorporated the IERG into its Ten-year Plan for Education 2006-2015.

The IERG has as its goal the creation of an environmental consciousness in youth and adults. It seeks to implement a comprehensive educational model that will require technology and infrastructure that is on par with other parts of Ecuador. It is envisioned that the process itself will inspire proactive approaches and new teaching and curricular models based on scientific research.

To put the challenge associated with educational reform into perspective, this article presents basic data regarding the educational system in Galapagos from 2001 to 2008, a period of rapid population growth.

The current educational system in Galapagos

There are 29 educational institutions in Galapagos of different levels: pre-school, primary and secondary, with the majority in the canton of Santa Cruz (13 institutions), followed by the canton of San Cristóbal (11), which includes Floreana as a parish, and the canton of Isabela (5) (Table 1).

Table 1. Educational institutions in Galapagos by canton and type of institution, according to grade level in each. Code: PS = pre-school (3 and 4 years); P = Primary; S = Secondary.

Type	San Cristóbal					Santa Cruz					Isabela				
	PS & P to 7th grade	PS & P to 10th grade	PS, P, & S	P & S	TOTAL	PS & P to 7th grade	PS & P to 10th grade	PS, P, & S	P & S	TOTAL	PS & P to 7th grade	PS & P to 10th grade	PS, P, & S	P & S	TOTAL
Public*	4	1	0	1	6	5	0	0	3	8	2	0	0	0	2
Public/ Catholic Church*	0	1	0	1	1	0	0	1	0	1	1	0	0	1	2
Municipal	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Private	0	0	1	0	1	0	0	2	0	2	0	0	0	0	0
Distance learning	0	0	0	2	2	0	0	0	2	2	0	0	0	0	0
Total	4	2	1	4	11	5	0	3	5	13	4	0	0	1	5

* Public schools are financed by the government, while Public/Catholic Church schools receive funds from both the government and the Catholic Church.

The students and teachers

There are a total of 454 teachers in the three levels of education in Galapagos, with an average student:teacher ratio of 14:1 (Table 2). The best student:teacher ratio is in San Cristóbal where there are only 11 students for every teacher.

Table 2. Total number of teachers and students and the student:teacher ratio by canton.

Canton	Students	Teachers	S:T Ratio
San Cristóbal	2115	188	11.3
Santa Cruz	3641	227	16.0
Isabela	522	39	13.4
Total	**6278**	**454**	**13.8**

Source: Provincial Directorate of Education

In the current school year (2008-2009), there are a total of 6278 students, with the majority (79.2%) in the primary educational level (1st to 10th year), followed by 14.4% in the secondary level (1st to 3rd year), and 6.4% in pre-school (3 to 4 years old). From the school year 2001-2002 to now, there has been an increase of 1883 students, which corresponds to the general population growth (Table 3).

Table 3. Growth of the student population since the school year 2001-2002 and projections to the school year 2009-2010, at all levels (Pre-school, Primary and Secondary).

School Year	No. of Students	No. increase per year
2001-2002	4445	
2002-2003	4667	222
2003-2004	4900	233
2004-2005	5145	245
2005-2006	5402	257
2006-2007	5672	270
2007-2008	5956	284
2008-2009	6278	322
2009-2010	6567	289

Source: Provincial Directorate of Education

Photograph: Cristina López

The majority of students attend educational institutions that are within the public and public-Catholic church system (approximately 80%). Only Santa Cruz and San Cristóbal have private schools and locations for distance learning, both with low percentages of students. However, unlike Isabela, these two islands have no municipal education centers (Figure 1).

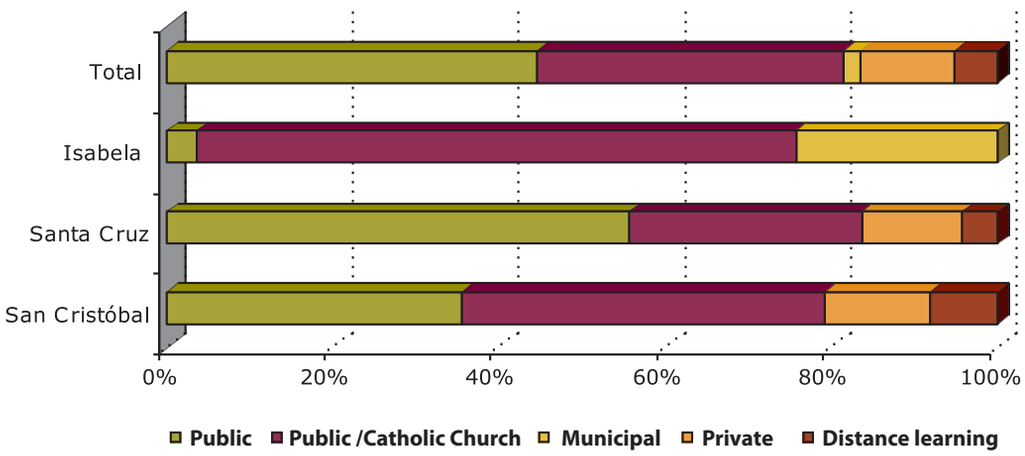

Figure 1. Percentage of students that attend the different types of educational centers, by island.

Source: Provincial Directorate of Education

The number of high school graduates has remained relatively stable in recent years, ranging from 193 to 235 per year. As expected, the schools on Santa Cruz graduate the largest number of students, with the Colegio Nacional Galápagos graduating the greatest number in the entire province. In San Cristóbal, the Instituto Alejandro Humboldt graduates the most students (Table 3).

Table 4. High school graduates in Galapagos by canton and institution for each year from 2001-2002 to 2006-2007. Diplomas are in Sciences (physics, mathematics, chemistry, biology, general sciences) and Technical Fields (commerce, information management, accounting, tourism, and cooking).

Canton / Educational Institution	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	Total	
							No.	%
San Cristóbal								
Inst. Alejandro Humboldt	54	60	45	47	46	52	304	24
Unid E. Liceo Naval	0	0	0	0	0	16	16	1
C. Ignacio Hernández	18	17	34	21	30	12	132	10
Total	**72**	**77**	**79**	**68**	**76**	**80**	**452**	**35**
Santa Cruz								
Nacional Galápagos	60	65	61	80	69	48	383	30
Miguel Ángel Cazares	18	28	14	23	38	32	153	12
Particular Loma Linda	10	12	12	11	15	5	65	5
U. Educ. Tomás de Berlanga	0	0	0	0	0	6	6	0
Fisc. San Francisco	24	18	15	35	20	13	125	10
Total	**112**	**123**	**102**	**149**	**142**	**104**	**732**	**57**
Isabela								
C. Agustín Azkunaga	19	10	12	15	17	23	96	8
Total	**19**	**10**	**12**	**15**	**17**	**23**	**96**	**8**
Total in Galapagos	**203**	**210**	**193**	**232**	**235**	**207**	**1280**	**100**

Source: Régimen Escolar DPEG.

Moving Forward

The increase in the number of students in all educational levels in Galapagos represents a significant challenge for teachers who are aware of the importance of a new integrated curriculum and the difficulty inherent in creating a shared environmental consciousness.

Through its National Plan 2006-2015, the Ministry of Education has already begun to strengthen both the primary and secondary levels of education in Galapagos with additional, qualified professionals. Both primary and secondary education levels need teachers with academic profiles that are appropriate to the level of students being taught and the special academic needs described in the IERG. High school graduates in Galapagos should be qualified to enter the current labor market and, if they choose, to continue on to higher education in priority areas such as research, conservation, and business.

But to achieve lasting conservation in Galapagos, citizens must be fully prepared to participate in sustainable economic development opportunities and be able to appreciate and understand the unique surroundings in which they live. We must construct a true learning community in Galapagos and serve as advocates of the IERG, which we believe will provide local citizens with the necessary tools to create and maintain a shared vision for Galapagos.

i Plan Regional para la Conservación y Desarrollo Sustentable de Galápagos. INGALA 24 October 2002, number 3.3 Directrices para garantizar la sustentabilidad socioeconómica.

Value of the Basic and Essential Family Baskets in Galapagos

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Charles Darwin Foundation

The Ecuadorian National Institute of Statistics and Censuses (INEC – Instituto Nacional de Estadística y Censos) determines a monthly value for the Basic Family Basket (BFB) and the Essential Family Basket (EFB) at the national level, based on studies in Quito, Guayaquil, Cuenca, Loja, Manta, Esmeraldas, Machala, and Ambato (Annex 1). Galapagos is not included within the study areas and therefore there are no official values for these basic supplies in the archipelago.

This article presents a value for both the BFB and the EFB in Galapagos for January and April 2008, based on a study carried out on the three islands with the most inhabitants: Santa Cruz, San Cristóbal, and Isabela.

To calculate the value for the baskets, data on local prices were collected and the basket values calculated in accordance with the methodology used by INEC. Although the information obtained and presented in this article is not considered official by the Ecuadorian government, it provides a reference point for a comparison between Galapagos and the rest of the nation.

The methodology used to determine the values was as follows. First a total of 357 businesses were identified on the three islands included in the study (213 in Santa Cruz, 106 in San Cristóbal, and 38 in Isabela). Prices were then collected at distribution centers for each article included in the BFB (Annex 2) and the EFB (Annex 3) in January and April of 2008. Information was obtained from 95% of the businesses. Housing data were obtained through consultation with some tenants on the islands. The value of the two types of baskets was then calculated using the Consumer Price Index (CPI) methodology of INEC.

Basic Family Basket

INEC (1990) defines the BFB as "the combination of 75 articles (goods and services) acquired in a specific quantity considered the minimum amount that is indispensable to satisfy the basic needs of a typical home with four members, for food, housing, clothing, and miscellaneous items for one month."

The value of the BFB in Galapagos in January 2008 was US$652, in comparison to US$479 reported for continental Ecuador, signifying that goods

and services are 36% more expensive in Galapagos. The value in Galapagos in April was US$686 compared to US$496 on the continent, a 38% cost differential (Figure 1).

The national press (El Universo, 2008) reported that the increase in the value of the BFB in continental Ecuador between January and April (4%) was due to a variety of factors, including climatic variations in the mountains that resulted in an increase in the price of agricultural products, the increase in the price of basic materials, as well as the demand for rice and other products from neighboring countries, and the high international cost of petroleum.

The higher value of the BFB in Galapagos in relation to the continent is primarily due to the cost of the chain of transportation required to bring products to market, including the costs of sourcing items on the continent, preparing shipments, air and maritime transport, shipping taxes, and mark-ups by local merchants in Galapagos. The increase in the value from January to April was primarily due to the increase that occurred on the continent. Most of the products included in the BFB come from the continent, so their prices were directly affected. An additional factor was product scarcity in February 2008 that resulted when two of the principal cargo ships that transport food to Galapagos broke down, leaving the population in the archipelago without a regular supply of goods.

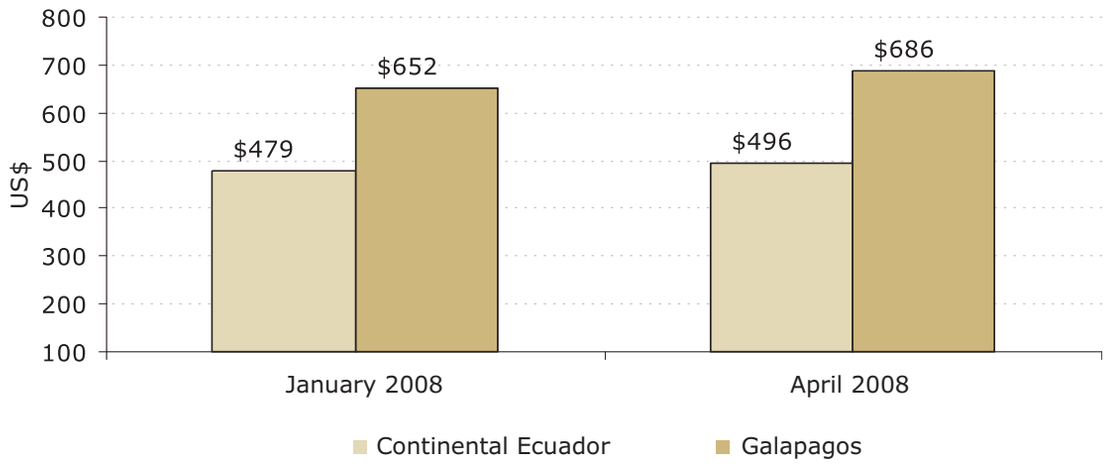

Figure 1. Value of the BFB in January and April 2008 in Galapagos and continental Ecuador.

Basic Family Basket by island

Isabela is the most expensive island with a BFB of US$760 in January 2008 and US$784 in April (an overall value 58% higher than on the continent). San Cristóbal and Santa Cruz had values more than $100 less than Isabela (Figure 2).

The factor that contributes most to the high cost on Isabela is the transport of food items, many of which come from Santa Cruz. Direct flights from the continent to San Cristóbal and Baltra (the island adjacent to Santa Cruz) result in a lower value for the BFB on those two islands. Isabela does not have an airport that can receive commercial flights from the continent.

The difference in the cost of the BFB in Galapagos between January and April (US$33.8) is nearly double that observed on the continent (US$17) (Table 1). According to those interviewed, this increase was due to the scarcity of products and the lack of price controls. The difference on San Cristóbal (US$43.3) was greater than Santa Cruz (US$36.1) and Isabela (US$24.8).

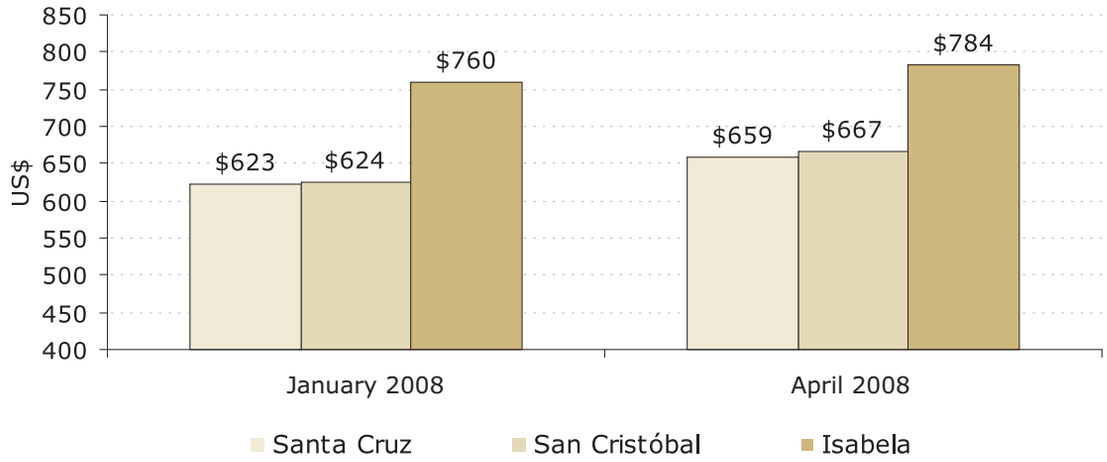

Figure 2. Value of the BFB by island for January and April 2008.

Table 1. Value of the BFB in January and April 2008 and the increase between the two months, in continental Ecuador and on the three main inhabited islands of Galapagos.

LOCATION	JANUARY (US$)	APRIL (US$)	INCREASE BETWEEN JANUARY AND APRIL	
			US$	%
Continental Ecuador	478.8	495.8	17.0	3.5
Galapagos	651.6	685.4	33.8	5.1
Santa Cruz	623.3	659.4	36.1	5.7
San Cristóbal	623.9	667.2	43.3	6.9
Isabela	759.7	784.5	24.8	3.2

Sources: INEC 2008; Estudio Canasta familiar en Galápagos, CDF 2008.

Basic Family Basket in 2001

According to a previous article on the Family Basket in Galapagos (Fundación Natura, 2002), the value of the BFB in Galapagos in 2001 was US$513, 65% higher than in continental Ecuador where it was US$310 (Figure 3.). In 2008, the value of the BFB in Galapagos was only 38% higher than on the continent. The greater difference between the continent and Galapagos in 2001 as compared to 2008 was due to factors such as inflation, which in April 2001 equaled 14.43%, while in April 2008, inflation was only 5.18% (INEC, 2008; El Universo, 2008). In addition, in 2001 there was considerable economic instability in Ecuador due to the conversion to the US dollar.

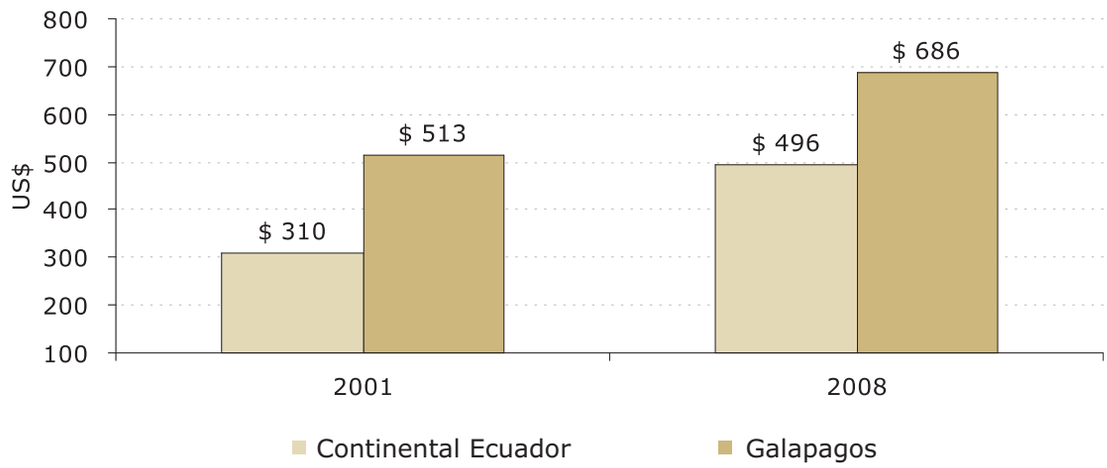

Figure 3. Value of the BFB in continental Ecuador and Galapagos in 2001 and 2008.
Sources: Informe Galápagos 2001-2002; Estudio Canasta Familiar en Galápagos, CDF 2008.

In 2001 the value of the BFB showed little variation among the inhabited islands of Galapagos. San Cristóbal had the lowest cost (US$502), followed by Isabela (US$517), and Santa Cruz (US$519). In 2008 there was a different result, with the value of a BFB in Isabela 19% greater than Santa Cruz and 18% greater than San Cristóbal.

Essential Family Basket

The EFB, known as the "poverty basket," differs from the BFB in that it "contains 73 articles (goods and services) – consumed in lower amounts than the articles of the BFB – that a family of four of a medium economic means could acquire to cover their basic necessities" (INEC, 1990).

In January 2008, the value of the EFB in continental Ecuador was US$335, while in Galapagos it was US$490. In April the value in Galapagos was US$517, significantly greater (48%) than the US$350 registered in continental Ecuador (Figure 4).

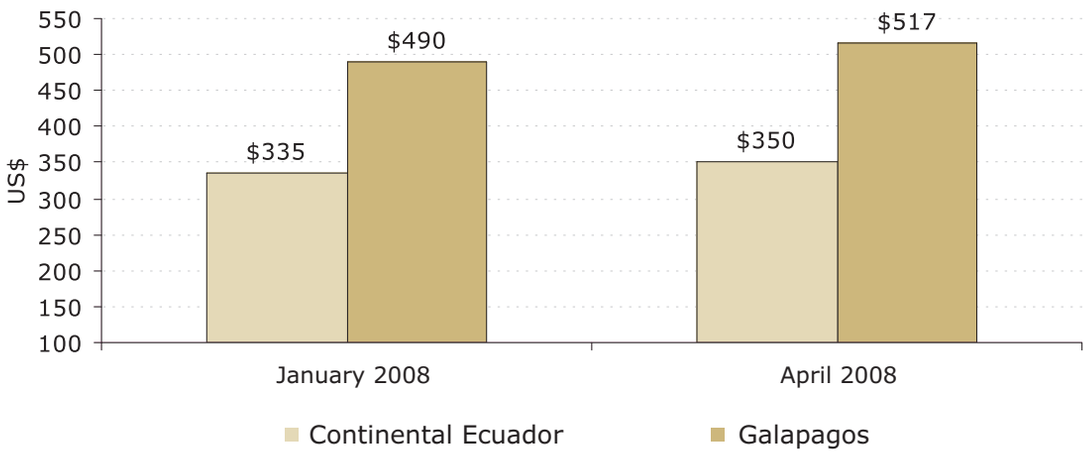

Figure 4. Value of the EFB in January and April 2008 in continental Ecuador and Galapagos. Sources: INEC 2008; Estudio Canasta Familiar en Galápagos, CDF 2008.

As with the BFB, the value of the EFB was higher in Isabela than in San Cristóbal and Santa Cruz (Figure 5), although the difference among islands was less for the EFB than for the BFB (Table 2).

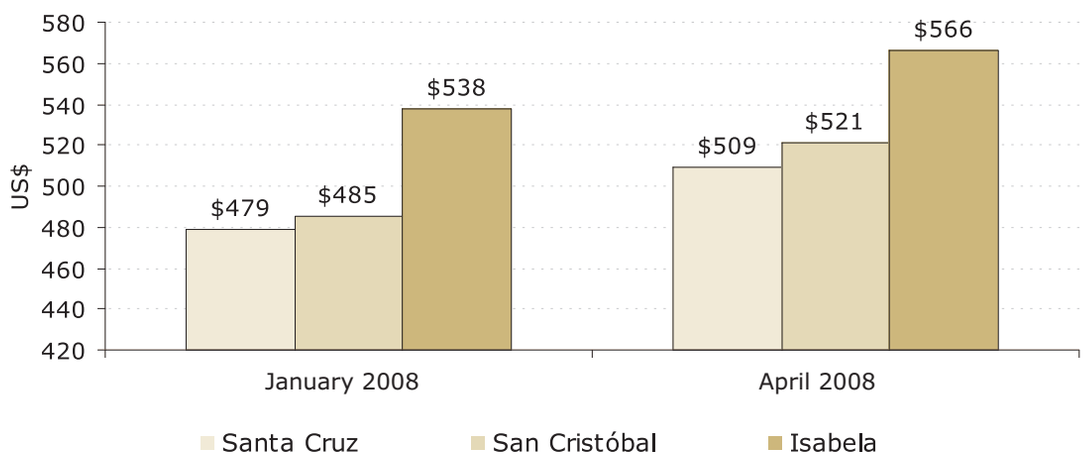

Figure 5. Value of the EFB in January and April 2008, by island.

Table 2. Value of the EFB in January and April 2008, and the increase from January to April, in continental Ecuador and in the three main inhabited islands of Galapagos.

LOCATION	JANUARY (US$)	APRIL (US$)	INCREASE FROM JANUARY TO APRIL	
			US$	%
Continent	334.7	349.7	15.0	4.4
Galapagos	489.8	516.7	26.9	5.5
Santa Cruz	478.8	509.1	30.3	6.3
San Cristóbal	485.0	520.8	35.8	7.4
Isabela	538.4	565.4	27.0	5.0

Sources: INEC 2008; Estudio Canasta Familiar en Galápagos, CDF 2008.

Conclusions

The cost of basic products is definitely greater in Galapagos than in continental Ecuador due to factors already discussed in this article, such as the cost of transport from the continent to the islands. However additional factors, such as lack of governmental controls, below standard product transport, and limited agricultural planning in Galapagos also influence the difference in prices.

The cost of basic products is definitely greater in Galapagos than in continental Ecuador

As an insular ecosystem located at 1000 km from continental Ecuador, Galapagos is poor in resources and must depend upon production on the continent. However, several alternatives exist that could reduce the difference in costs between the islands and the mainland. Ongoing monitoring of compliance with official prices could ensure that retail businesses maintain prices at more just and equitable levels. Increasing the quality and frequency of transport from the continent to the islands could potentially reduce product scarcity, thus avoiding speculation and subsequent increases in prices. Finally, a well-organized and sustainable agricultural sector in Galapagos could help to reduce the price of products that can be produced in the archipelago.

Annexes

ANNEX 1. Value (US$) of the Basic Family Basket in various cities in continental Ecuador in 2008. Source: INEC, 2008

CITY	JANUARY	APRIL	INCREASE BETWEEN JANUARY AND APRIL	
			US$	%
Cuenca	510.45	522.66	12.21	2.39
Loja	483.16	506.21	23.05	4.77
Quito	481.42	497.38	15.96	3.32
Guayaquil	479.71	492.92	13.21	2.75
Manta	471.68	487.79	16.11	3.42
Esmeraldas	469.64	489.33	19.69	4.19
Machala	461.47	484.07	22.60	4.90
Ambato	444.31	463.65	19.34	4.35

Annex 2. Value (US$) of the products (by category) included in the BFB in Galapagos in January and April 2008, by island.

	January				April			
	Galapagos	Santa Cruz	San Cristóbal	Isabela	Galapagos	Santa Cruz	San Cristóbal	Isabela
Foods and beverages	**230.6**	**224.7**	**249.3**	**267.7**	**261.0**	**255.6**	**287.0**	**285.0**
Cereals and by-products	37.2	40.7	31.3	35.6	43.2	44.7	40.8	43.4
Meat and preparation	32.2	30.9	36.7	30.2	37.8	36.0	44.9	33.8
Fish and seafood	4.8	5.0	4.8	4.4	5.5	5.6	5.9	5.2
Fats and oils	6.7	6.3	6.5	8.0	8.3	7.7	8.3	9.9
Dairy products and eggs	47.2	46.1	44.3	52.6	49.8	49.5	44.4	57.3
Fresh vegetables	18.1	18.2	16.7	21.7	22.5	23.3	20.6	24.2
Tubers and by-products	19.1	17.2	37.4	18.2	23.0	19.7	51.1	22.3
Legumes and by-products	4.3	4.1	4.9	4.3	5.2	5.2	5.6	5.3
Fresh fruit	12.8	12.9	13.1	14.1	13.9	14.2	13.5	14.5
Sugar. salt. and condiments	8.8	8.4	9.3	8.6	10.0	10.0	10.6	9.4
Coffee and carbonated beverages	9.6	7.9	15.8	33.9	9.9	9.2	11.7	21.1
Other products	2.6	1.1	2.7	3.8	2.2	1.4	2.9	3.5
Other foods and beverages	27.2	25.8	25.8	32.3	29.8	29.1	26.7	35.1
Housing	**226.5**	**206.2**	**185.7**	**287.4**	**227.4**	**207.3**	**186.6**	**288.2**
Rent	190.0	170.0	150.0	250.0	190.0	170.0	150.0	250.0
Lighting and fuel	21.5	21.4	21.1	22.0	21.6	21.4	21.0	22.2
Cleaning and maintenance	13.7	13.7	13.4	13.8	14.3	14.4	14.2	14.3
Other home appliances	1.3	1.1	1.2	1.6	1.5	1.5	1.4	1.7
Clothing	**23.7**	**24.6**	**23.6**	**21.5**	**22.4**	**24.4**	**21.8**	**21.5**
Fabrics. sewing. and accessories	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Manufactured clothing - men's	11.3	12.3	11.0	10.5	10.5	12.3	9.8	10.5
Manufactured clothing - women's	8.8	8.7	9.0	7.4	8.3	8.5	8.4	7.4
Cleaning services	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Miscellaneous	**170.8**	**167.8**	**165.2**	**183.2**	**174.5**	**172.1**	**171.8**	**189.8**
Health care	96.7	96.4	94.8	105.6	99.6	99.9	96.3	107.7
Care of person and property	17.1	17.1	17.8	14.9	17.3	17.1	18.3	16.1
Recreation. reading	8.2	4.8	4.8	13.9	7.2	6.6	4.6	11.6
Tobacco	11.2	11.9	10.2	11.2	12.8	10.9	15.0	16.8
Education	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4
Transportation	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2
TOTAL	**651.6**	**623.3**	**623.9**	**759.7**	**685.4**	**659.4**	**667.2**	**784.5**

Annex 3. Value (US$) of the products (by category) included in the EFB in Galapagos in January and April 2008, by island.

	January				April			
	Galapagos	Santa Cruz	San Cristóbal	Isabela	Galapagos	Santa Cruz	San Cristóbal	Isabela
Foods and beverages	**207.2**	**201.4**	**229.2**	**222.5**	**234.4**	**229.2**	**263.8**	**247.9**
Cereals and by-products	29.6	32.5	24.7	28.1	34.2	35.5	32.2	34.4
Meat and preparation	30.1	28.8	34.3	28.2	35.3	33.6	41.9	31.6
Fish and seafood	3.8	4.0	3.8	3.7	4.5	4.5	4.7	4.4
Fats and oils	6.2	5.8	5.9	7.3	7.5	7.1	7.6	9.1
Dairy products and eggs	35.7	34.7	34.0	39.6	38.1	37.6	35.1	43.7
Fresh vegetables	17.4	17.8	15.9	20.4	21.1	22.0	19.2	22.6
Tubers and by-products	17.6	15.5	39.2	16.0	20.8	17.4	52.7	19.5
Legumes and by-products	4.3	4.0	5.2	4.4	5.3	5.1	6.2	5.4
Fresh fruit	14.2	14.3	14.3	16.0	15.6	16.0	14.9	16.4
Sugar. salt. and condiments	5.9	5.7	6.2	5.8	6.7	6.7	7.1	6.3
Coffee and carbonated beverages	7.0	5.8	10.9	12.8	6.6	6.4	6.8	9.9
Other products	3.6	1.5	3.8	5.2	3.0	2.0	3.9	4.7
Other foods and beverages	31.8	31.0	31.0	35.0	35.7	35.3	31.5	39.9
Housing	**163.6**	**161.5**	**141.0**	**192.8**	**164.4**	**162.5**	**141.8**	**193.7**
Rent	121.6	120.0	100.0	150.0	121.6	120.0	100.0	150.0
Lighting and fuel	27.3	27.0	26.7	27.9	27.3	27.1	26.6	28.1
Cleaning and maintenance	13.1	13.2	12.9	13.1	13.7	13.7	13.5	13.6
Other housing appliances	1.6	1.3	1.5	1.9	1.8	1.7	1.7	2.0
Clothing	**23.4**	**24.0**	**23.6**	**21.4**	**22.2**	**24.0**	**21.8**	**21.3**
Fabric. sewing. and accessories	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Manufactured clothing - men's	10.3	11.1	10.1	9.7	9.6	11.3	9.0	9.7
Manufactured clothing - women's	8.9	8.7	9.3	7.4	8.4	8.5	8.6	7.4
Cleaning services	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Miscellaneous	**95.6**	**91.9**	**91.1**	**101.6**	**95.6**	**93.4**	**93.4**	**102.5**
Health care	22.5	21.7	21.4	25.5	23.0	22.2	21.7	25.8
Care of person and property	18.1	18.6	18.7	15.1	18.1	18.1	19.1	16.0
Recreation. reading	8.7	5.1	5.1	14.8	7.7	7.0	4.9	12.3
Tobacco	4.4	4.6	4.0	4.4	5.0	4.2	5.8	6.5
Education	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Transportation	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
TOTAL	**489.8**	**478.8**	**485.0**	**538.3**	**516.7**	**509.1**	**520.8**	**565.4**

Public acceptance of environmental restrictions

Hugo Barber[1] & Pablo Ospina[2]

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This article is based on a survey carried out in March 2008 (Table 1) and the results of meetings of four focus groups[1] that were held on the three most populated islands of Galapagos. It evaluates the level to which Galapagos residents are willing to accept a number of limitations to their lifestyle, their patterns of consumption, and their material aspirations, based on environmental considerations. We analyze their attitudes towards immigration, resource use, and the special legislation for the province.

Table 1. Technical data on the surveys.

	1997	1998	1999	2000	2001	2006	2008
Month of survey	July	October	September	January	November 2000	June	March
Sample total	377	427	582	553	573	442	487
Isabela	102	109	160	150	151	102	104
San Cristóbal	147	158	209	203	213	147	185
Santa Cruz	128	160	213	200	209	193	198
Standard error	±5.2	±4.8	±4.1	±4.3	±4.2	±4.7	±4.5

Sources: Fundación Natura/Fondo Mundial para la Naturaleza (2002: 53); Barber and Ospina (2006), and Opinion Survey of March 2008.

Immigration

Survey results from 2008 confirm the same trend since the initiation of these surveys in 1997 (Fundación Natura/Fondo Mundial para la Naturaleza 2002): there is a significant resistance to immigration. The growing number of new and recent immigrants has not caused any significant variation in the perception that immigration increases crime, unemployment, and environmental damage. However, as in previous years, there is a lower acceptance of immigration restrictions when it involves members of one's own family. Half of the people that agree that immigration increases crime, unemployment, and environmental degradation, do not believe that these impacts are sufficient cause to justify immigration restrictions for their relatives (Figure 1).

1 A focus group is a type of collective interview, generally with a group of people with relatively homogeneous characteristics. The four focus groups used in this study had a range of five to nine people; interviews lasted for two to three hours.

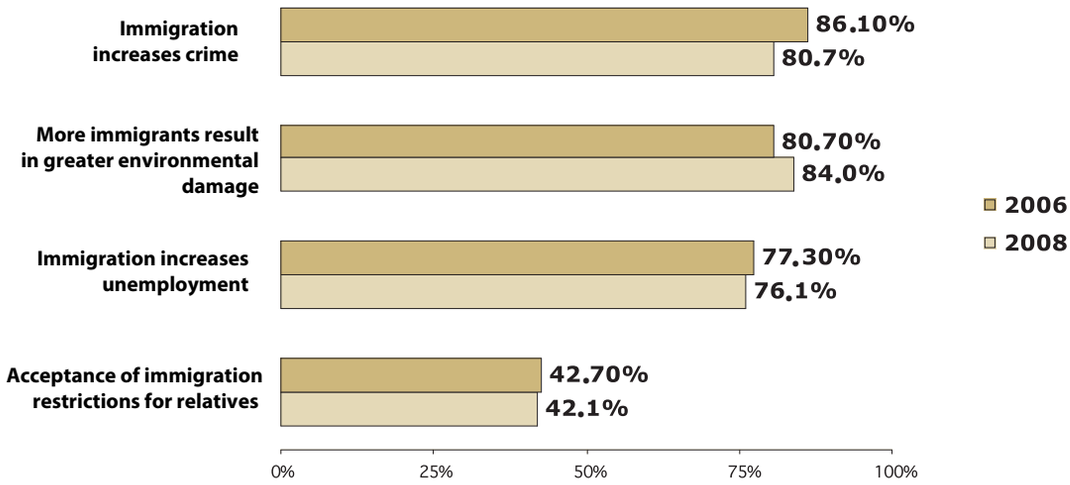

Figure 1. Attitudes toward immigration in 2006 and 2008.

Responses in Santa Cruz, the most populated island in Galapagos, are the most notable. While there is greater concern on this island regarding immigration, there is also greater resistance to immigration restrictions for relatives. The relationships among other variables are more predictable: the older the person and the greater portion of their life lived in Galapagos, the greater their tendency to oppose immigration and to accept immigration restrictions for their own family. Contrary to what one might expect, Galapagos natives are not the most opposed to new immigration. It appears that age is a stronger determining factor than place of birth in this regard.

Table 2. Attitudes regarding immigration by island and age (%).

Phrase	Total	Island			Age			
		Isabela	San Cristóbal	Santa Cruz	18 to 24 years	25 to 34 years	35 to 49 years	50 and older
Immigration increases crime	80.7	76.0	74.0	84.8	82.2	80.6	79.4	81.8
More immigrants result in greater environmental damage	84.0	76.0	77.9	88.4	84.9	83.3	84.7	82.4
Immigration increases unemployment	76.1	72.2	75.2	77.3	72.5	72.3	78.6	82.3
Acceptance of immigration restrictions for relatives	42.1	61.6	53.6	33.3	37.3	41.7	40.3	53.6
AVERAGE	**70.7**	**71.5**	**70.2**	**70.9**	**69.2**	**69.5**	**70.8**	**75.0**

Table 2. Continuation.

Phrase	Gender		Time in Galapagos*		
	Male	Female	Less	More	Born in Galapagos
Immigration increases crime	77.0	83.6	76.5	82.5	80.6
More immigrants result in greater environmental damage	84.0	84.0	78.6	85.4	86.1
Immigration increases unemployment	72.7	78.8	73.7	79.3	71.0
Acceptance of immigration restrictions for relatives	40.1	43.6	49.1	40.0	40.2
AVERAGE	**68.5**	**72.5**	**69.5**	**71.8**	**69.5**

Note: Data weighted by population size on each island
* "Less" indicates someone who has lived in Galápagos for less than one third of their current age; "More" indicates someone who has lived in Galapagos for more than one third of their current age.

Exploitation of resources

With respect to use of natural resources, there is a general acceptance (eight of every ten people surveyed) of the prohibition of shark fishing and of harvesting native timber (Figure 2). The six percent reduction in the acceptance of closed fishing seasons between 2006 and 2008 (a time at which fishing closures were being debated) is not statistically significant. However, the slight increase in support for the idea of limiting the number of tourists is statistically significant (Figure 2).

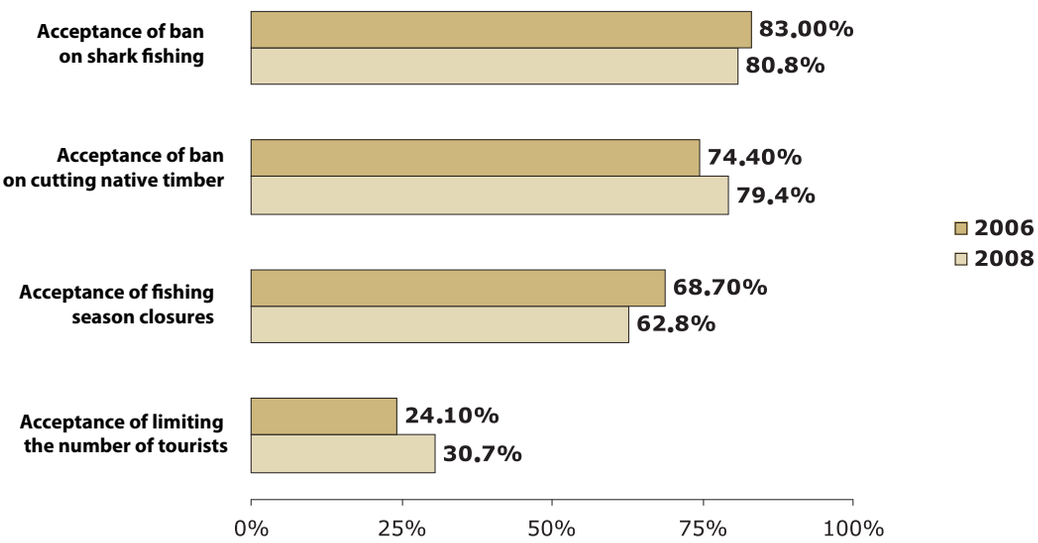

Figure 2. Attitudes regarding exploitation of resources in 2006 and 2008.

The analysis of opinions on the ban on shark fishing and on limiting the number of tourists demonstrates the contrast between the economic bases of the two islands. While the ban on shark fishing is greatly accepted on Santa Cruz (a tourism port), acceptance is much weaker on Isabela, where fishing plays a much greater role in the local economy (Table 3). On the other hand, although the support is generally less for the establishment of limits to the number of tourists (important social expectations exist for a greater economic benefit from tourism), there is greater acceptance of the idea on Isabela and San Cristóbal than on Santa Cruz (Table 3). Another element that arises from this analysis is that the older residents and natives of Galapagos are those who most favor a restriction on the number of tourists (Table 3).

Table 3. Attitudes regarding restrictions on exploitation of natural resources (%).

Phrase	Total	Island			Age			
		Isabela	San Cristóbal	Santa Cruz	18 to 24 years	25 to 34 years	35 to 49 years	50 and older
Acceptance of ban on shark fishing	80.8	52.0	71.3	89.9	87.5	85.2	75.5	75.9
Acceptance of ban on cutting native timber	79.4	62.5	75.7	83.8	85.9	75.6	77.5	80.8
Acceptance of fishing season closures	62.8	78.9	64.4	59.6	52.7	67.2	57.1	83.0
Acceptance of limiting the number of tourists	30.7	36.5	36.7	26.7	33.1	28.9	26.0	41.1
AVERAGE	**63.4**	**57.4**	**62.0**	**65.0**	**64.8**	**64.2**	**59.0**	**70.2**

Table 3. Continuation

Phrase	Gender		Time in Galapagos*		
	Male	Female	Less	More	Born in Galapagos
Acceptance of ban on shark fishing	74.5	85.7	87.3	82.0	71.3
Acceptance of ban on cutting native timber	78.4	80.2	78.0	81.3	76.1
Acceptance of fishing season closures	67.6	59.0	52.9	61.9	74.6
Acceptance of limiting the number of tourists	33.0	28.9	22.6	29.7	41.4
AVERAGE	**63.4**	**63.4**	**60.2**	**63.7**	**65.8**

Note: Data weighted by population size on each island
* "Less" indicates someone who has lived in Galapagos for less than one third of their current age; "More" indicates someone who has lived in Galapagos for more than one third of their current age.

Environmental legislation

Acceptance of the Special Law for Galapagos increased from 2006 to 2008, with more people viewing it as good both for conservation and for Galapagos residents. However, the opinion that it imposes unnecessary environmental restrictions has also increased. For example, the majority of residents believe that the protected areas are too large and that environmental protection is merely a pretext for imposing restriction on island residents (Figure 3).

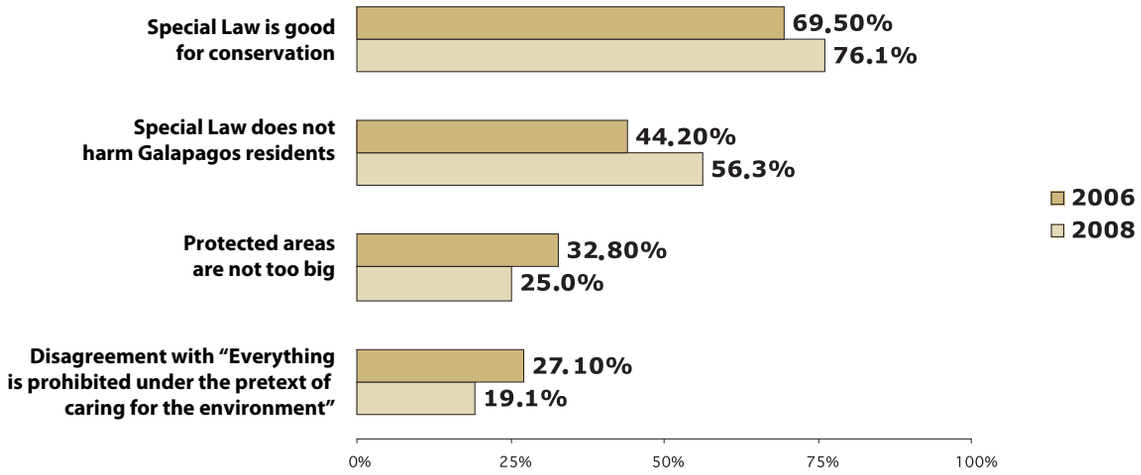

Figure3. Attitude regarding environmental legislation in 2006 and 2008.

Residents in San Cristóbal show the least acceptance of environmental legislation. Fewer people believe that the Special Law for Galapagos is good for conservation and that it does not harm residents (Table 4), while more people believe that protection of the environment is just a pretext for restrictions. Only with regard to the size of protected areas do the residents of Isabela demonstrate a more unfavorable opinion than those in San Cristóbal (Table 4). Residents of Isabela strongly believe that the size of protected areas is too large. A large majority of residents of the three islands (an average of 75%) hold the view that protection of the environment is used as a pretext for imposing restrictions.

Photograph Cristina López

Table 4. Opinions regarding environmental legislation (%).

Phrase	Total	Island			Age			
		Isabela	San Cristóbal	Santa Cruz	18 to 24 years	25 to 34 years	35 to 49 years	50 and older
Special Law is good for conservation	76.1	81.7	67.6	79.8	78.6	78.4	71.7	79.2
Special Law does not harm Galapagos residents	56.3	53.8	42.7	63.6	58.0	54.6	57.4	54.3
Protected areas are not too big	25.0	13.5	28.6	24.7	31.6	25.3	20.6	24.3
Disagree with "Everything is prohibited under the pretext of protecting the environment"	19.1	20.2	14.6	21.2	16.7	17.6	16.7	30.4
AVERAGE	**44.1**	**42.3**	**38.4**	**47.3**	**46.2**	**44.0**	**41.6**	**47.1**

Table 4. Continuation.

Phrase	Gender		Time in Galapagos*		
	Male	Female	Less	More	Born in Galapagos
Special Law is good for conservation	77.2	75.3	68.6	78.9	77.1
Special Law does not harm Galapagos residents	60.7	52.8	51.9	58.3	55.8
Protected areas are not too big	23.6	25.9	22.7	25.2	26.5
Disagree with "Everything is prohibited under the pretext of protecting the environment"	21.8	17.0	15.6	20.3	19.6
AVERAGE	**45.8**	**42.7**	**39.7**	**45.7**	**44.8**

Note: Data weighted by population size on each island
* "Less" indicates someone who has lived in Galápagos for less than one third of their current age; "More" indicates someone who has lived in Galapagos for more than one third of their current age.

Trends

Over the last decade, the average acceptance of environmental restrictions has not varied significantly when only the five questions used in all years are considered. Most people continue to accept the ban on shark fishing and on cutting native timber (Table 5). The lowest levels of acceptance are for quarantine restrictions and limits on the number of tourists. The fishing season closures received the lowest acceptance of all throughout the decade. This is probably due to the fact that fishermen have lived through a period of prolonged closures, the continuation of which was under discussion when the survey was completed. Finally, the acceptance of migratory restrictions for relatives continues to be low, especially when compared to the social concerns regarding immigration, but is higher than previous years.

Table 5. Acceptance of environmental restrictions from 1997-2008.

Phrase	1997	1998	1999	2000	2001	2006	2008
Accept ban on shark fishing	70.6	77.6	70.5	74.0	69.1	83.0	80.8
Accept quarantine measures*	69.9	77.3	74.2	73.7	74.3	42.0	30.7
Accept ban on removing sand from beaches	79.1	90.4	90.4	85.5	77.3	ND	ND
Accept fishing season closures	70.1	76.7	79.6	79.9	74.9	69.0	62.8
Accept ban on cutting native timber	64.9	77.6	78.5	77.8	57.9	74.4	79.4
Accept ban on sea cucumber fishing	60.4	62.8	37.3	31.5	24.9	ND	ND
Accept immigration restrictions for relatives	27.4	32.7	37.5	36.4	32.3	42.7	42.1
Accept limiting the number of tourists	48.9	42.4	32.6	36.5	42.3	24.0	30.7
Average acceptance of environmental restrictions						55.8	54.4

Note: Data weighted by population size on each island

* Data are not comparable because the question differed in 2006 and 2008 from previous years. In previous Galapagos Reports survey participants were asked if they were in agreement or disagreement with the phrase: "I would allow them to review my luggage for quarantine." Later the phrase was: "They should allow us to bring all types of fruits and vegetables to Galapagos because they are cheaper."

Sources: Data from 1997 to 2001 in Fundación Natura/Fondo Mundial para la Naturaleza (2002:54); data from 2006 and 2008, Opinion Survey, June 2006 and March 2008

Conclusions

What is most evident in the evaluation of the 2006 and 2008 surveys, and in the comparison with trends over the past decade, is the consistency of opinion of Galapagos residents with respect to acceptance of environmental restrictions. In general, acceptance of restrictions related to extractive activities is much greater than acceptance of those related to day to day life in Galapagos. In fact, there is a lower acceptance of restrictions related to three major areas of human activity that have serious impacts on the health and vitality of Galapagos ecosystems: immigration, tourism, and quarantine controls. This occurs because the restrictions in these three areas require greater and more profound changes in behavior than do those associated with the extraction of resources.

Public Opinion of Institutional Performance in Galapagos

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The purpose of this article is to demonstrate the evolving public image of the principal institutions of the province. It is based primarily on a survey taken in March 2008 (Table 1) and on results from meetings with four focus groups[1] on the three most populated islands. First we review the components of institutional image (positive vs. negative), then evaluate recent changes by island, and finally present comparisons showing the evolution of institutional images over the last decade.

Table 1. Dates and numbers of surveys.

	1997	1998	1999	2000	2001	2006	2008
Month completed	July	October	September	January	November 2000	June	March
Total No. Surveys	377	427	582	553	573	442	487
Isabela	102	109	160	150	151	102	104
San Cristóbal	147	158	209	203	213	147	185
Santa Cruz	128	160	213	200	209	193	198
Standard Error	±5.2	±4.8	±4.1	±4.3	±4.2	±4.7	±4.5

Sources: Falconí (2002: 53); Barber & Ospina (2006) and Opinion Survey of March 2008.

Image in 2008

As in previous years, the survey investigated the subjective "perception" of Galapagos residents towards institutions in the province in terms of their credibility, honesty, efficiency, concern for the community, and acceptance of citizen participation in institutional decisions. While studies of confidence in institutions in continental Ecuador have used a different methodology and are not totally comparable with the Galapagos study, they do show that there is a general lack of confidence in political institutions in the country.

In practically all cases there are more people with a negative perception of the institutions than with a positive perception. This is also evident in all

1 A focus group is a type of collective interview, generally with a group of people with relatively homogeneous social characteristics. The four focus groups that were used in this study had a range of five to nine people; the length of the interview ranged from two to three hours.

of the focus groups, with a lack of confidence in the work of the institutions most dominant. Only the municipalities and the provincial government received a net positive result regarding "concern for the community" and "acceptance of citizen participation." In all other cases, there are more people who think that the institutions are dishonest, lack credibility, use their resources poorly, are not concerned for the community, and do not accept citizen participation in their decision-making (Table 2). In the case of the institutions that are primarily dedicated to conservation (which, according to the responses of a number of the people surveyed, includes the governor's office), the negative view is reinforced by the perception that they have significant economic capacity. This perception was confirmed through the qualitative analysis in focus groups in the three islands, where participants considered the conservation organizations as the "richest" but the least interested in helping the community and doing their job.

Table 2. Public image of selected institutions* in Galapagos, March 2008 (%).

	Governor's Office	Provincial Government	CDF	INGALA	Municipalities	GNPS	Navy	None	U/NR
Credible	19.7	24.4	28.1	25.7	33. 0	26.2	25.9	24.8	11.7
Not credible	39.6	36.6	32.4	41.6	34.7	40.4	34.2	8.8	22.3
Does its work well	13.8	22.9	28.0	21.5	31.2	24.0	26.0	20.1	15.4
Does its work poorly	32.4	26.8	24.3	36.1	26.0	36.2	24.3	8.6	29.8
Honest	11.9	15.9	17.5	14.7	18.5	12.5	17.0	35.1	24.8
Dishonest	38.2	35.2	33.9	37.7	36.1	39.2	33.1	10.3	38.3
Concerned about the community	23.7	41.1	20.3	25.0	58.9	21.7	19.1	14.9	8.0
Not concerned about the community	26.1	19.5	31.3	25.5	17.4	33.4	28.3	12.3	32.2
Has significant economic capacity	19.0	19.3	43.6	27.7	29.2	64.9	16.6	3.5	12.1
Has limited economic capacity	17.1	20.1	16.3	18.8	27.4	7.2	27.5	10.5	29.7
Efficient use of resources	8.2	18.7	14.5	9.3	23.9	14.5	12.0	22.9	27.7
Poor use of resources	28.7	26.0	26.9	29.9	25.1	36.9	24.8	4.5	44.4
Involves citizens in decision-making	19.1	26.3	10.0	16.6	41.2	11.2	7.2	22.0	17.0
Does not involve citizens in decision-making	27.7	21.1	31.6	30.1	20.0	35.4	33.9	5.7	39.9

U/NR= Unknown/No response
Note: Data weighted according to the population of each island. For a comparison with data from 2006, see Galapagos Report 2006-2007, p. 92
* Acronyms: CDF = Charles Darwin Foundation; INGALA = National Institute of Galapagos; GNPS = Galapagos National Park Service.

The most drastic decline in the public image of all of the institutions occurred in Isabela (Table 3). In 2006 Isabela had the highest opinions of all of the institutions with the exception of the Charles Darwin Foundation (CDF), but in 2008 the image of public institutions in Isabela is lower than the average in almost all cases. In San Cristóbal, the images of the development institutions (National Institute of Galapagos – INGALA, provincial government, and municipalities) are above average, while the images of the "conservation" institutions are below average. In Santa Cruz, public opinion towards conservation institutions appears increasingly similar to that in San Cristóbal. In both cases, as the favorable view towards "conservation" institutions declines, the favorable perception of "development" institutions increases. The qualitative analysis of these perceptions tends to confirm that although the perceptions are negative for all of the institutions, there is a marked difference between the image of the larger and seemingly more distant conservation institutions and the weaker but more accessible local institutions that promote development.

Table 3. Institutional image index, 2006-2008, by island (%).

INSTITUTION	ISABELA		CRISTÓBAL		SANTA CRUZ		TOTAL	
	2006	2008	2006	2008	2006	2008	2006	2008
Governor's Office		15.4		14.3		17.1		16.1
Provincial Government	25.5	15.1	23	37.0	15.9	20.1	18.3	24.9
CDF	24.8	15.2	19	17.4	29.3	21.6	26.3	19.7
INGALA	20.6	19.9	12.9	19.0	14	18.5	14.1	18.8
Municipalites	43.3	38.8	28.9	35.0	27.7	33.5	28.9	34.5
GNPS	32.4	17.5	15.3	15.9	21.2	19.8	20.3	18.4
Navy		19.7		22.1		15.4		17.9

Source: Opinion surveys from June 2006 and March 2008.
Notes:
- The index is constructed as a simple average of favorable opinions with respect to credibility, efficient use of resources, honesty, concern for the community, doing its work well, and acceptance of citizen participation in decision-making.
- Data weighted according to the population of each island.
- The index does not include the variable on economic capacity because it is value-neutral.

Trends

In terms of public perception, conservation institutions had their best moment from 1997 to 1999, when a combination of political and social forces led to the approval of the Special Law for Galapagos. By 2001, however, favorable opinions declined for all institutions, in some cases abruptly. In the case of the Galapagos National Park Service (GNPS) and the CDF, public perception is once again approaching the critical 2001 level (Table 4, Figure 1). The municipalities have the most stable image over time. INGALA has not yet recovered from the decline in 2001, although its image has begun to improve. The provincial government also appears to have recuperated although it has not yet achieved its highest level recorded in 1999 and 2000 (Figure 1). The general trend is toward a modest improvement in institutional image of those institutions that promote socioeconomic "development" and a decline in the image of those institutions involved in "conservation."

Table 4. Positive index of institutional image, 1998 - 2008 (%).

Year Month	Governor's Office	Provincial Government	CDF	INGALA	Municipalities	GNPS	Navy
1997 Aug.		22	33	30	27	36	
1998 Oct.		23	37	28	27	44	
1999 Sept.	16	42	39	31	27	48	
2000 Dec.	11	34	28	29	35	30	
2001 Nov.	9	23	12	18	33	16	
2006 June		18	29	14	27	21	
2008 March	16	25	22	19	33	20	20

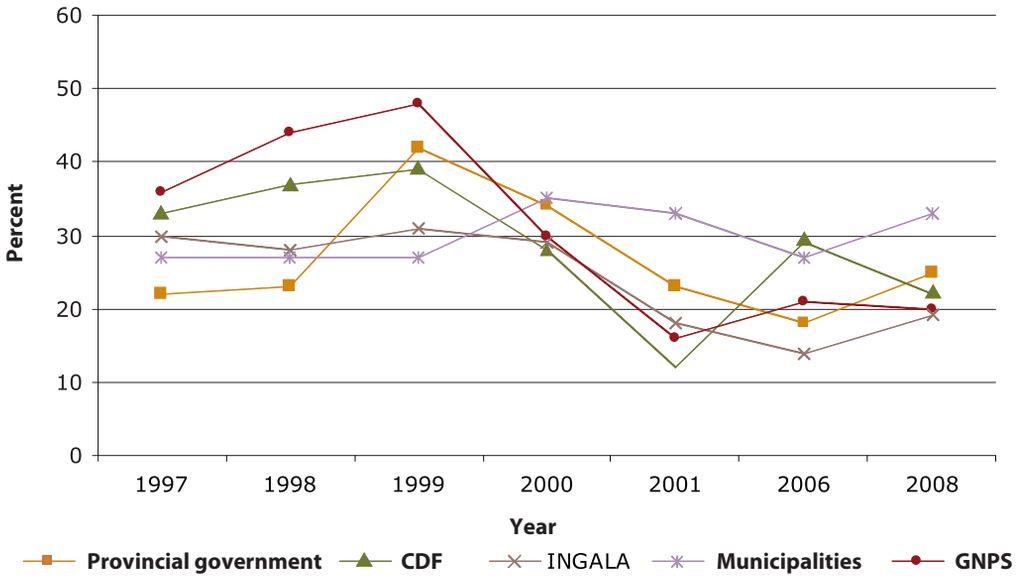

Figure 1. Index of positive institutional image, 1998 - 2008 (%).

Sources: For 1997 – 2001, Falconí (2002:57); for 2006 y 2008, Opinion Survey of June 2006 and March 2008.
Notes:
- The index is constructed as a simple average of the favorable opinions with respect to credibility, efficient use of resources, honesty, concern for the community, and doing their work well.
- Data weighted according to the population of each island.
- To make the indices comparable, the average for 2006 and 2008 does not include the additional variable about involving citizen participation in decision-making (for this reason, the values in this figure do not coincide with the values in Table 2).
- The index does not include the variable on economic capacity because it is value-neutral.

It is difficult to explain the reasons for these trends. What can be suggested, based on other studies in Galapagos (Ospina 2006; Grenier 2007), is that 11 years ago, negotiations surrounding the Special Law for Galapagos created high expectations among the local population that changes in attitudes and policies related to conservation in the islands would benefit Galapagos residents. It is possible that the current poor perception of conservation organizations is due to the fact that these expectations were never fully met. The same could be applicable to the case of INGALA, which was a key component of the institutional framework created in 1998. During this same period, the enactment of the Special Law increased the budgets of the municipalities through the so-called "15% Law," which has increased their capacity to carry out public works. In addition, the 1998 Constitution gave the municipalities the opportunity to assume various additional responsibilities above and beyond those assigned by the Law of Municipal Government. It is possible that the combination of increased budget and a broader mandate has helped these institutions to maintain a stable public image.

Gender and women's rights in Galapagos[1]

Rocío Rosero & Cecilia Valdivieso[1]

The Special Law for Galapagos of 1998 states that "the quality of life of residents of the province should be consistent with the exceptional characteristics of the Galapagos World Heritage site." However, the inequality, poverty, and exclusion that constitute cultural problems in other parts of Ecuador are part of the daily life of those who live in Galapagos.

Environmental problems are very closely related to economic and social problems, making it difficult to distinguish between the human and environmental dimensions of development. In this sense, a focus on gender makes it possible to look at the different impacts of resource management on the lives of women and men. This article presents information related to gender issues in Galapagos for decision-making and the formulation of public policy.

This study presents quantitative information from the Census of the Population and Housing of Galapagos of 2006 (INEC, 2006) and qualitative information collected through interviews, focus groups, and testimonies in San Cristóbal, Isabela, Santa Cruz, and Floreana. A total of 81 individuals were consulted (48 women and 35 men), including authorities, decision-makers, public servants, civic leaders, and women's organizations.

The Galapagos population

According to the population census of 2006, there are 19 184 inhabitants in Galapagos, of which 9234 are women and 9950 are men (INEC, 2006). Overall, there are 92.8 women for every 100 men, although this ratio varies among the cantons: 87.4 in Isabela, 89.2 in San Cristóbal (which includes Floreana), and 95.8 in Santa Cruz. Galapagos is the only province in Ecuador where men outnumber women.

In Galapagos, women are head of household in 19.8% of homes. Gender of the head of household does not appear to impact access to basic services.

Employment and the right to work

According to census data, 47.6% of the population of Galapagos is economically active; women represent 35.5% of this group (Figure 1). In nearly all age groups, there are twice as many economically active men as there are

1 This article is part of the "Diagnóstico de Género y Derechos de las Mujeres de Galápagos" developed by the authors for the Project ARAUCARIA XXI and the Galapagos National Park. May to August 2008.

women. In the segment of 65 years and older, the difference is even greater. It is unfortunate that two children younger than 11 years old are currently working and were recorded as part of the economically active population.

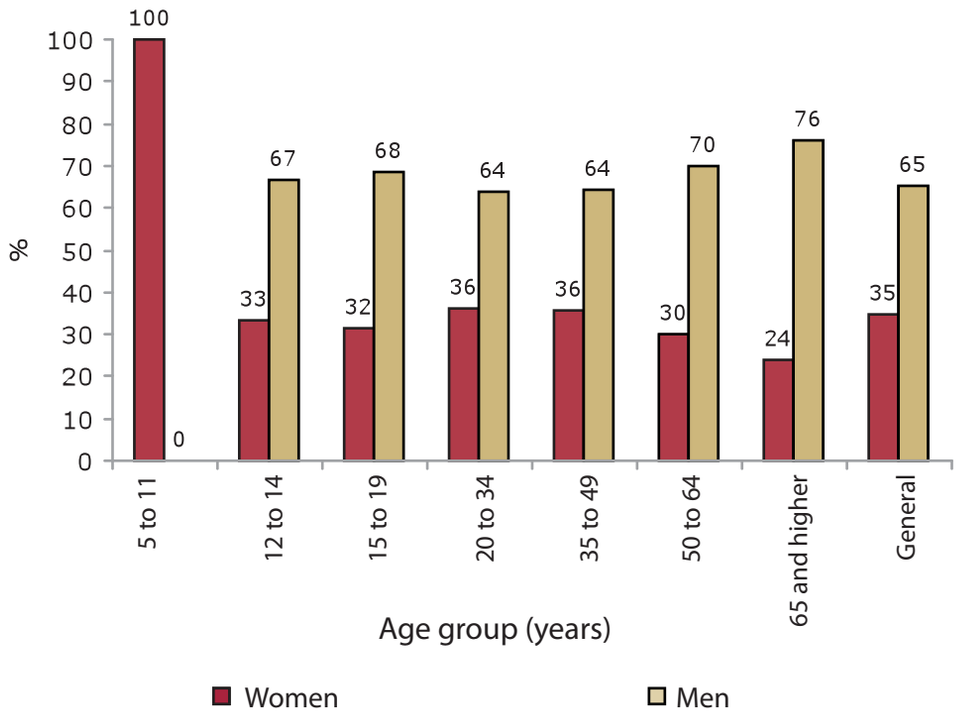

Figure 1. The currently economically active population by gender and age group (INEC, 2006).

The study reveals that a larger percentage of women are concentrated at lower income levels. For example, 42.7% of women compared to 39% of men earn between US$101-400 per month (Table 1). The greatest difference occurs in the US$401-700 range, which includes 24.6% of men and 15.2% of women.

Galapagos has experienced an accelerated economic growth related to the increase in tourism. This growth has created more sources of employment, primarily for men (Figure 2). However, young people—both men and women—express difficulty in finding work outside of tourism because they lack skills demanded by the labor market and cannot access the training and education needed to build those skills.

Although women occupy some decision-making positions in both the public sector and tourism, most are employed in lower-level, lower-paying positions. Approximately 12% of women earn less than US$100 per month in the informal sector as street vendors or employees or owners of micro-enterprises. This figure is similar on the mainland.

Table 1. Number and percentage of women and men at different income (US$) levels (INEC, 2006).

Income Level (US$)	Men		Women		Total	% Women
	Number	%	Number	%		
Less than 100	436	7.5	390	12.3	826	47.2
101 to 400	2 254	39.0	1 357	42.7	3 611	37.6
401 to 700	1 425	24.6	482	15.2	1 907	25.3
701 to 900	437	7.6	218	6.9	655	33.3
901 to 2000	682	11.8	387	12.2	1 069	36.2
2001 and higher	128	2.2	47	1.5	175	26.9
No income	108	1.9	136	4.3	244	55.7
Unknown	315	5.4	158	5.0	473	33.4
Total	**5 785**	**100.0**	**3 175**	**100.0**	**8 960**	**35.4**

The right to education

In Galapagos, 5.2% of men and 5.9% of women are illiterate. This difference is greater in rural areas. On Isabela, for example, 4.4% of women in the rural areas are illiterate, compared to 2.2% of men.

In terms of education, only 29.6% of women and 31.6% of men have completed primary education; 36.5% of women and 39.1% of men have completed secondary education; and 18.5% of women and 15.6% of men have completed higher education (Figure 2). The economic situation of families directly affects whether young adults are able to continue with advanced education and increase their professional opportunities.

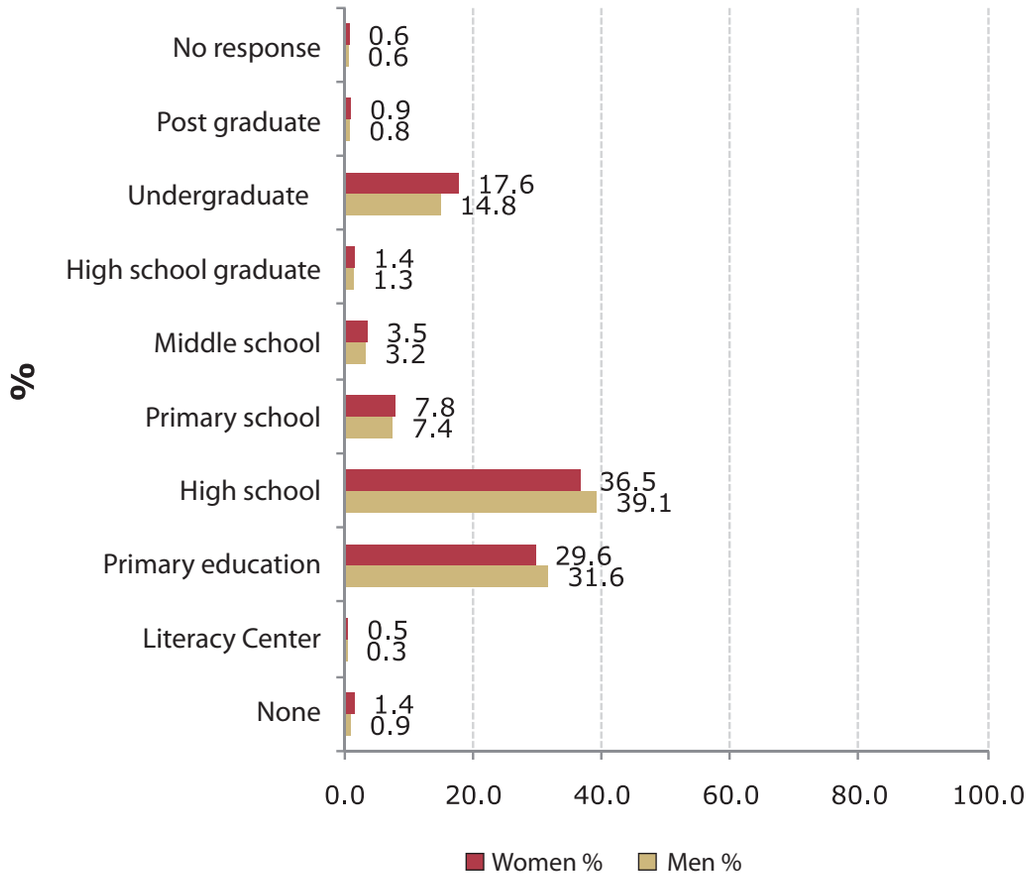

Figure 2. Level of education completed by gender (INEC, 2006).

All of the individuals interviewed believe that education in Galapagos does not respond to local needs and that there is a high level of discrimination in the schools based on the socioeconomic background of the child. It is also believed that the educational system reinforces traditional roles for young girls and adolescents (Lara, 2006: 42). Sex education is considered to be inadequate both at school and in the home.

The right to a life free of abuse

Sexual abuse is an extreme form of discrimination against women, violating a series of rights: the right to life; physical, psychological, and sexual well-being; healthy growth and development; freedom of thought and opinion, and freedom of choice related to reproductive health. Violence against women limits their independence, the development of self-esteem, and possibilities to enjoy the rights of education, health, employment, and control and access to resources. Violence limits their potential to improve their quality of life and that of their family and to contribute to the development of the country.

According to the information obtained in this study, violence in Galapagos families is caused by: high levels of alcoholism

among men; a culture of disrespect towards women; the lack of dialogue between parents and children; and unstable homes due to the high level of migration between Galapagos and the mainland.

The lack of support mechanisms to provide attention to victims of sexual abuse in Galapagos means that women must approach the police who are not sufficiently trained to deal with these crimes and who do not always adequately apply the Law of Violence against Women and the Family. Reliable statistical records of abuse are not kept.

Among Galapagos women of reproductive age (15 to 49 years old), 23.2% report that they received either physical or psychological abuse prior to reaching 15 years of age (ENDEMAIN, 2004).

Records from various institutions in Galapagos provide evidence of an increase in violence against women, girls, and adolescents (Table 2). Detailed information on cases involving children and adolescents can be found in Maldonado (in this Galapagos Report).

Violence and abuse is a public health problem and the publication of the Ministry of Health, "Indicadores Básicos de Salud en Ecuador," requires that all cases be documented. The Ministry recorded 10 cases of violence and abuse in 2007.

Table 2. .Reports of various types of abuse

Period	Island	Institution	Data
January 2004 to June 2007	San Cristóbal	National Sheriffs Office	161 reports of intra-family abuse
2006	San Cristóbal	National Police	161 calls for assistancedue to intra-family abuse
2006	San Cristóbal	Office of the Rights of Women of the Police - ODMU	Types of abuse recorded: 104 physical and 28 psychological 131 of the 132 records correspond to women
2006	San Cristóbal	Galapagos Police Headquarters	19 offences of intra-family abuse
January to May 2007	San Cristóbal	National Police	140 calls for help
January to May 2007	San Cristóbal	Galapagos Police Headquarters	71 reports: 59 of physical abuse and 12 of psychological abuse
January 2007 to April 2008	San Cristóbal	National Police Headquarters Specialized in Children and Adolescents - DINAPEN	51% report abuse of the rights of girls or female adolescents 5 of the 28 reports were for sexual abuse
January to June 2008	San Cristóbal	Galapagos Police Headquarters	9 reports of intra-family abuse
January to December 2007	Santa Cruz	National Sheriffs Office	181 reports of intra-family abuse
January to June 2008	Santa Cruz	National Sheriffs Office	76 reports of intra-family abuse

Health and sexual and reproductive rights

In the area of sexual and reproductive health, those interviewed expressed concern over the high incidence of early sexual relations and marriage, and adolescent pregnancies, all of which make it more difficult for women to take advantage of educational opportunities and to join the labor force.

According to the 1990 census, 13.3% of Galapagos women between 12 and 19 years of age have at least one child (INEC, 1990). Adolescent pregnancies declined to 8.9% in 1998 (INEC, 1998) and then even lower to 7.2% in 2006 (INEC, 2006).

The decline could be related to the level of formal education, sex education programs, and access to and use of birth control methods.

This information conflicts with the results of the Ecuador Demographic and Maternal–Child Health Survey (ENDEMAIN) published in 2004. Based on interviews with 10 814 women of reproductive age, the ENDEMAIN survey indicated that in Galapagos women have an average of 2.7 children, while in the Amazon women have an average of 4.2 children. According to this same source, the average age at which a woman has her first child in Galapagos is 22 years, which is significantly higher than in any of the other three regions of the country. ENDEMAIN also notes that women in Galapagos have their first sexual relation at an average age of 18.7 years, which corresponds to the national average (Figure 3).

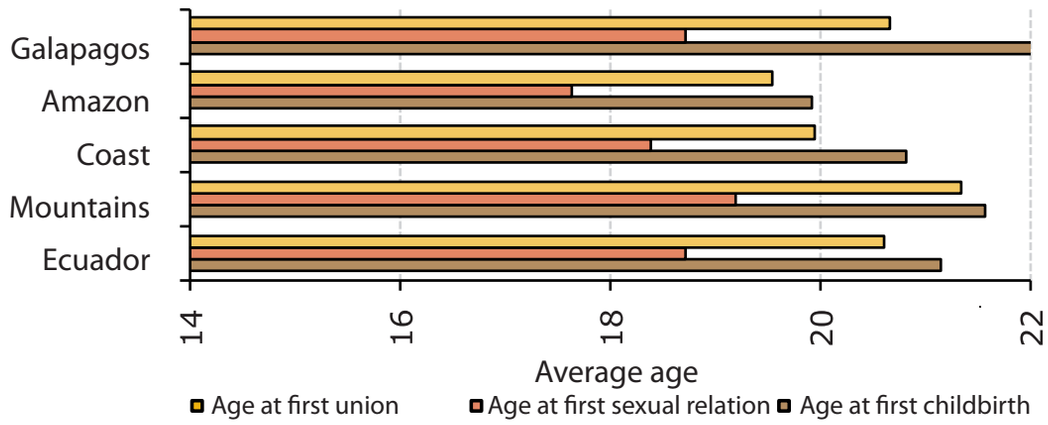

Figure 3. Age at first union, age at first sexual relation, and age at first childbirth of women of reprodcutive age, in the different regions of Ecuador. Source: ENDEMAIN, 2004

According to the records of the República del Ecuador Hospital in Santa Cruz, 12 cases of HIV and 6 cases of AIDS were diagnosed between 1995 and January 2008. Four of these cases involved women who do unpaid domestic work. In 2006, the National AIDS Program of the Ministry of Public Health recorded only two cases of HIV/AIDS in Ecuador, which confirms the under-reporting of this pandemic. Some officials of the Ministry of Public Health in Galapagos indicated that there is a high incidence of HIV/AIDS cases that are treated through private consultations, and in their opinion HIV/AIDS represents the most serious health problem in the province.

The system for recording information related to sexual and reproductive rights must be improved. In addition, resources must be invested in studies to analyze the provision of services for sexual and reproductive health, the availability of medical specialists, the resources needed to ensure the implementation of the Free Maternity and Child Care Law, and the quality and impact of education programs that promote healthy and responsible sexuality.

Political participation

The presence of women in both elected and appointed positions has increased in recent years due to the Quota Law, in force since 2000. Currently the Prefect in Galapagos is a woman as is one town council member in San Cristóbal (for the period 2007-10) and one in Isabela (2004-08), but none in Santa Cruz.

In the 2006 local elections in Galapagos, the Quota Law, which requires 45% women on ballots, was not observed. Only 32.3% of the candidates for town councils were women and in the case of the provincial council, only 25% of the candidates were women. The elections produced only 14.3% women among the town councils and 50% in the provincial council (Table 2).

Table 2. Percentage of women candidates and those elected to office at the local level. Source: Tribunal Supremo Electoral, 2006. Note: the national value includes Galapagos.

	Municipal Council women		Provincial Council women	
	Candidates	Elected	Candidates	Elected
Galapagos	32.3	14.3	25.0	50.0
NATIONAL	**41.4**	**23.0**	**39.0**	**14.9**

In the national elections for congress in 2006, two men were elected to represent the province. The last time a woman represented Galapagos in the national congress was in 1998-2002. No woman was elected to represent Galapagos in the Constitutional Assembly, even though the slates of candidates conformed to the requirements of the Quota Law; only one of the eight slates had a woman as the principal candidate.

Conclusions

Many of the social indicators in Galapagos are superior to those in mainland Ecuador, suggesting that the quality of life in the archipelago is better than on the continent. Recent economic growth tied to tourism is without doubt one of the factors that explains this situation. Ospina (2000) describes Galapagos as prosperous compared with the difficult conditions of Ecuadorian society on the whole.

The same can be said about women's rights and gender equality.However, although much of the data reveal only small differences in the rights of men and women in Galapagos, this does not ensure that the quality of life is what it should be.

One of the big challenges for the authorities in Galapagos is to define and implement public policies regarding gender and the promotion of equality and inclusion through stronger local public institutions. To achieve this, it will be important to review the current level of observance of rights, create an Equal Opportunity Plan for women and men in Galapagos and develop quantitative and qualitative indicators that will go beyond "cold numbers" to provide a solid foundation for decision-making.

Increasing social and political participation of women is also a priority. This will involve: 1) training to build and consolidate leadership; 2) establishing mechanisms to encourage the participation of women at all levels of decision-making and in political parties; and 3) designating the necessary resources to develop and promote these actions.

Some aspects of life in Galapagos that require a more careful review include: 1) differences in access, use, and control of natural resources among the population; 2) abuse of women in Galapagos (dimensions of the problem as well as possible public policy); 3) the current level of adolescent pregnancy; 4) gender, migration, and family; 5) workplace conditions of paid women workers; 6) political participation and leadership by women; 7) sexual exploitation in Galapagos; and 8) access of women to education and technology.

The lack of remuneration for domestic work and caretaking, the limited participation of men in childcare, hiring and wage discrimination against women, and the low levels of education of women and their lack of participation in the formal labor market are all phenomena that result from unequal power relationships both within the family and in the public arena. They also contribute, as they do on the mainland, to poverty among women.

Those interviewed in this study warn that the principal problems related to gender and the rights of women are intra-family abuse, low quality education, and lack of employment opportunities and sources of income. They also point to a problem of governance that can be seen in the abundance of strategic and institutional plans that do not consider the differential impacts on men and women. The result is a general lack of public policies to ensure sustainable human development.

Carrying Capacity vs. Acceptable Visitor Load: Semantics or a substantial change in tourism management?

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2 Galapagos National Park

The use of Carrying Capacity as the predominant concept in tourism management assumes that there is a direct relation between the number of visitors to a tourist site and the impacts produced in the environment and on wildlife, and that these impacts can be managed via regulation of the number of people or groups of people that access visitor sites. Lacking other applicable approaches, Cifuentes (1984, 1992) took the concept of carrying capacity and further developed it as the primary management tool of the Galapagos National Park (GNP) for the boat-based tourism model of Galapagos in which the number of visitors is dependent upon the size of the tourist fleet. Initially the method was used to calculate the total carrying capacity or the total number of tourists permitted per year. In a later adaptation, the methodology was expanded to an evaluation of the daily carrying capacity of visitor sites (Cayot et al., 1996).

Carrying Capacity was adopted as a management tool because the concept is easy to understand and authorities and tourism operators wanted concrete numbers based on technical analyses to manage, monitor, and make future projections.

The results of the last carrying capacity study (Table 1, BID/FOMIN, 2007) oblige us to ask two fundamental questions. Does the calculation of Carrying Capacity of visitor sites effectively contribute to orient and potentially limit the development of tourism, the growth of the service infrastructure, or the size of the tourist fleet? And, does this management tool provide the type of data needed for tourism planning?

Table 1. Relationship of estimated Carrying Capacity of the Galapagos National Park and the Galapagos Marine Reserve to the overall capacity of the tourist industry in Galapagos.

Item	No.	Percent Estimate of "Overload"
Carrying capacity of visitor sites per year	102.425	
Capacity of air transportation per year (2007)	136.830	34%
Hotel and boat capacity per year (2007)	262.865	157%
Number of visitors arriving in 2007 for both land and sea tours	161.859	58%

Source: Determinación de la oferta actual y potencial del sector turístico en las Islas Galápagos, BID/FOMIN, 2007

Acceptable Visitor Load (AVL)

The Galapagos National Park (GNP) has successfully managed visitations to public use sites through systems of trails and visitor groups of limited size, which must be led by a naturalist guide. To a large degree, this approach has prevented measurable impacts in the Galapagos ecosystems.

In reality, no study has yet been able to demonstrate any significant or lasting changes in biodiversity or behavior or reproductive success of wildlife at visitor sites as a result of tourism activity. Reactions of the wildlife to the presence of humans are the same that occur when another similar-sized organism comes in close contact (e.g., sea lions). Many of the environmental impacts from tourism activities that have been observed are not related to the number of people present, but rather to their behavior and the lack of compliance with norms of conduct.

While no negative impacts have been detected, most fauna at visitor sites have adapted to the presence of visitors. Some birds have even shown a preference for nesting in areas exposed to regular tourist traffic. Animals cannot measure the size or the number of groups; therefore the groups do not have a cumulative effect on an animal's life. However, it is important to note that these results are specific for cases such as Galapagos, with few predators and a generally "tame" fauna, and are not applicable to forests or other ecosystems.

There is a clear and evident relationship between intensity of visits and levels of erosion in areas where ash, tuff, or sand predominate. However, these effects are localized and limited to the trails and can be mitigated with management measures such as walkways or stairs.

The more important variable is the number of people or Groups at Any One Time (GAOT), which determines the level of visual and physical interference associated with a visit. A high GAOT reduces visitor satisfaction and can increase physical impacts. For example, with a high GAOT, it is more common for visitors to leave the trail to avoid or pass another group. Ten groups in one site at the same time can cause significant visual pollution and eventually impact the flora and fauna due to lack of compliance with visitation rules, such as the requirement to remain on the trail. On the other hand, the same number of groups distributed over a number of hours (during which encounters between groups will be fewer) will not produce a significant impact. The impact of the number of visitors on overall visitor satisfaction is eliminated and the guide's control over their passengers is improved.

Other methodologies, such as the Recreational Opportunity Spectrum (ROS) and Limits of Acceptable Change (LAC), in which environmental and social qualities of the visitor sites are determined, have been used for zoning of public use space. They are based on criteria that focus not only on the level of naturalness required, but also on the expectations of different segments of the clientele (tourists), in terms of exclusivity, solitude, vehicular access, or in terms of levels of intervention, signage, and permissible conduct. A zoning scheme adapted to qualitative standards for different categories of visitors and activities permits a reduction in use in the highly sensitive areas while increasing it in highly resistant areas or in areas in which the

Photograph Jason Heilmann

number of people visiting at the same time is not an essential criterion.

The number of visitors allowed at a visitor site should not depend solely upon criteria that can be determined by mathematical formulas; rather it should depend upon qualitative criteria established by resource managers, which are based on local policies regarding the hoped-for quality of tourism. An alternative to the Carrying Capacity approach is the concept of Acceptable Visitor Load (AVL). AVL uses more subjective data, gathered through public participation and consultation, which include visual impacts, levels of perceived isolation or crowding, and a shared sense of the quality and type of visitor experience. In addition to its subjective components, calculations of AVL and GAOT will take into account various technical parameters, such as the category of each site, its area, the length of trails, the minimum distance between groups for each zoning category and opportunity, visibility factors, and the time required for a complete visit, including stopping for interpretation.

Based on GAOT, the number of groups that can visit a site in one day (the AVL) depends upon the length of the visit and also upon the number of "turns" that can occur without interference--a concept already used in the Physical Carrying Capacity as defined by Cifuentes (1992). Applying this concept depends upon effective internal organization of the tourism industry and the management and control capacity of the GNP. A number of complementary technical processes exist, in addition to AVL and GAOT, which can help manage the quality of the visitor sites in Galapagos, such as:

Network of ecotourism visitor sites for public use

System for awarding and renovating tourist operation permits

Registration and control of visitor entrance

Zoning system

Tourist Carrying Capacity

System of naturalist guides in protected areas

System of itineraries

Monitoring system for tourism

Control of tourism operations

The objective of this document is to offer new guidelines, based on the use of AVL, for reviewing the management strategies employed by the GNPS for tourism activities in visitor sites within the public use network of the GNP. As such, we do not offer nor attempt to offer solutions to the broader challenges posed by tourism.

The principal risks associated with tourism development do not occur at visitor sites, rather they are directly related to the total number of tourists and the resulting population growth (given that more tourists require a greater labor force). Growth in tourism and the resident population result in increased traffic between islands in the archipelago and with the continent, ever-increasing demands for food and energy, and a greater risk of introducing or transferring species to and among the islands. The concept of quality of visit in the visitor sites can help in the discussions concerning the limits of tourism, but will not resolve the serious indirect impacts that uncontrolled tourism development carries with it.

The changing organizational framework in Galapagos

Graham Watkins & Alejandro Martinez

Charles Darwin Foundation

From the early 1980s to today, the political and social landscape of Galapagos has substantially changed, as the local economy expanded and the resident population in the islands grew. This article examines organizational aspects of this change and looks at the number of organizations that influence decision-making in Galapagos and the number of organizational workplaces in the islands.

The Galapagos Islands are an oceanic archipelago with a small human population and a limited area for development. The islands provide an excellent setting to examine how a small, close-knit, island community organizes itself, particularly under the constraints of:

1) The difficulty in establishing economies of scale in organizations, making them less efficient and less cost-effective;

2) The scarcity of skilled and capable people because of the small population size and the consequent difficulty of finding qualified people to fill critical functions; and,

3) The increased costs of running organizations due to dependence on resources that must be transported to the islands.

The Galapagos Regional Plan (Ministerio del Ambiente, 2003) includes programs and projects to revise and strengthen organizations to reduce conflict, clarify areas of action, and increase efficiency. The Regional Plan also highlights weak leadership, political instability, and political patronage as risks to improved human organization. Despite the emphasis on organizations in the Regional Plan, in general, the organizational framework of Galapagos has received little critical attention. An analysis of civil society organizations in Galapagos was presented in the Galapagos Report 2000-2001 (Ospina, 2002). Here we complement this earlier paper and present trends related to both public and civil society organizations in Galapagos.

Photograph Alex Hearn

Local and central government organizations

Since 1980, the number of government institutions[1] in Galapagos responsible for public policy, regulations, and/or health and welfare has grown, resulting in an increasingly complicated governance framework (Figure 1). There are over 50 central government organizations and nine local government organizations with responsibilities in Galapagos; over 40 of these organizations have a physical presence in Galapagos (Annex 1). The growth in government workplaces[2] in Galapagos, using the dates of establishment of 126 locales in the five inhabited islands including state run schools and colleges, demonstrates the rapid growth in recent years (Figure 2).

According to the official government censuses, the number of employees in the public sector grew from 1237 in 1990 to 2115 in 2006, predominantly in central government organizations (Figure 3). In the last ten years, from 1997 to 2007, total government expenditures in Galapagos grew from an estimated US$10M to over US$40M[3] (Fundacion Natura, 2002).

The 1998 Special Law for Galapagos identifies the National Institute for Galapagos (INGALA) as the central planning organization and the INGALA Council[4] as the leadership, policy setting, and coordinating body for Galapagos. However, INGALA's role over the last ten years has been made difficult by: (i) leadership instability in central government organizations including INGALA itself; (ii) weak technical and planning capacities in INGALA; (iii) resistance to the governing role of the INGALA Council; and (iv) incomplete representation on the INGALA Council. The organizational complexity of Galapagos, in the absence of effective coordination, makes leadership, visioning, planning, and the realization of objectives difficult.

1 This analysis focused on the total number of organizations as one measure of organizational complexity and does not reflect variability in the relative sizes and influences of organizations, which adds additional complexity.

2 We included only government workplaces for which we were able to determine a reliable date of establishment.

3 Ministry of Economy and Finances http://mef.gov.ec

4 Membership of the INGALA Council includes the governor, three mayors, prefect, Ministry of the Environment, Ministry of Tourism, Ministry of Defense, Ministry of Economy and Finances, Ministry of Economic and Social Inclusion, Ecuadorian Committee for the Defense of Nature and the Environment (CEDENMA), Galapagos Chamber of Tourism (CAPTURGAL), fishing sector, agricultural sector, and the Charles Darwin Foundation as an official advisor without vote.

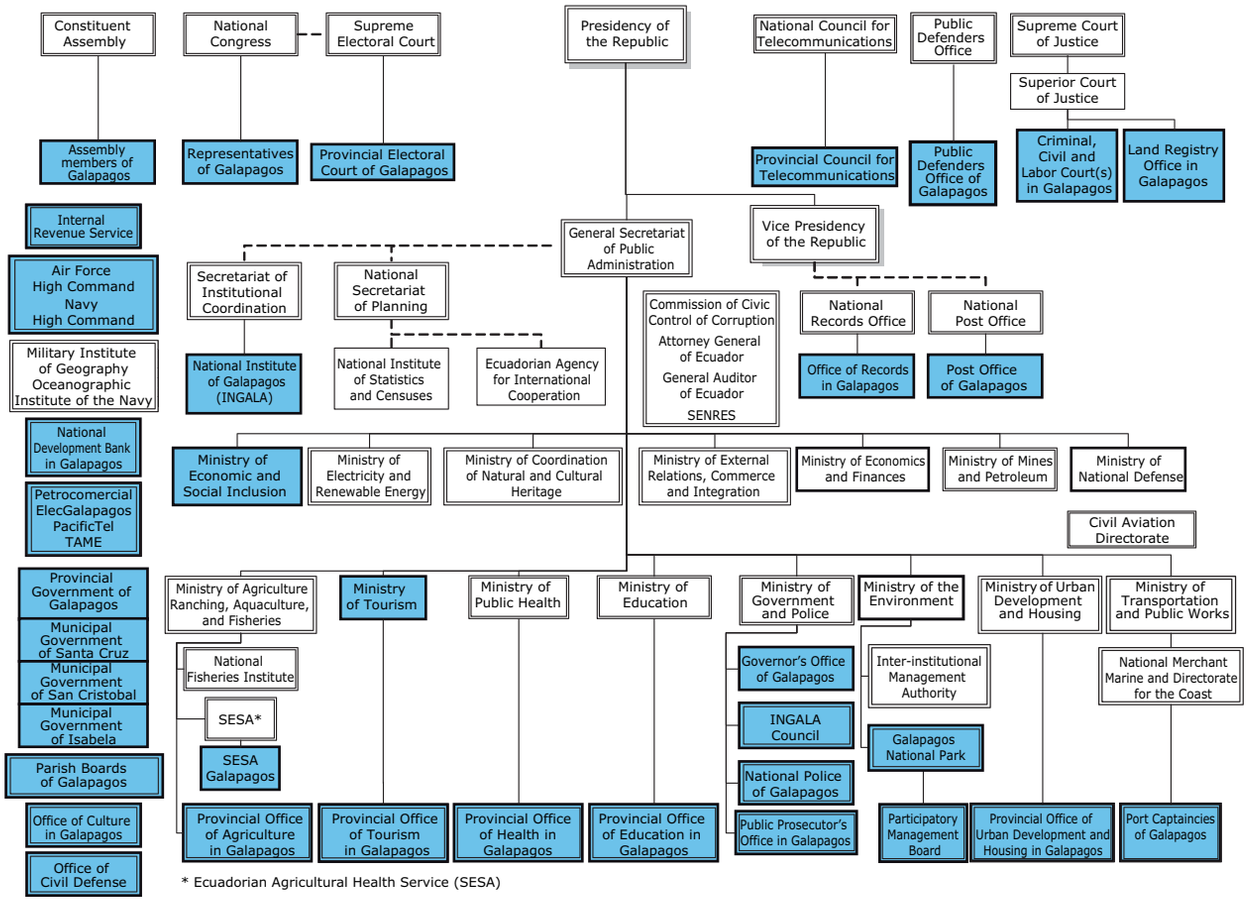


Figure 1. Government organizations with activities or policy-making responsibilities in Galapagos (blue institutions have offices in Galapagos; heavy-bordered organizations are members of the INGALA Council).[5]

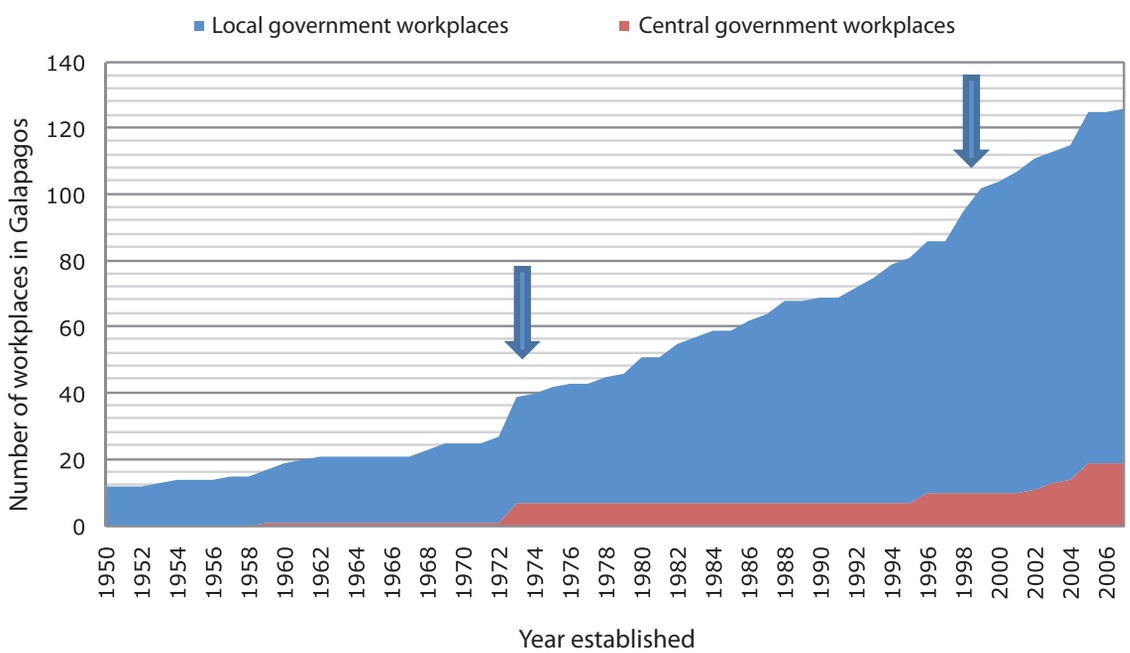


Figure 2. Growth in the number of government workplaces in Galapagos, based on their dates of establishment (arrows indicate the declaration of Galapagos as a province in 1973 and the Special Law for Galapagos in 1998).

5 Based on the ESTRUCTURA ORGÁNICA DEL SECTOR PÚBLICO ECUATORIANO, www.senres.gov.ec, updated December 2007.

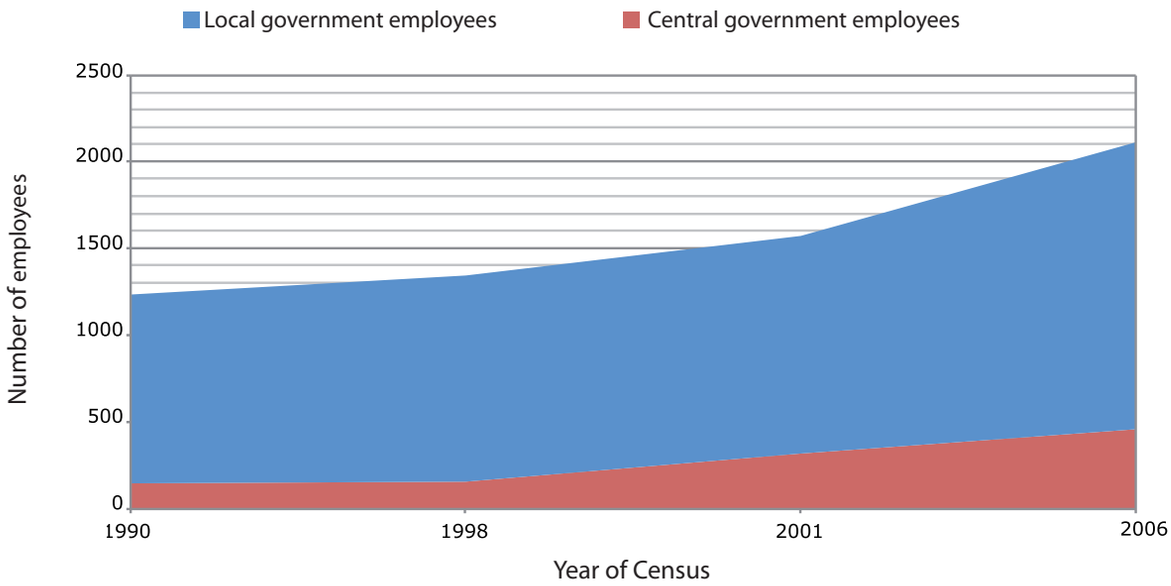


Figure 3. Number of employees in government offices in Galapagos by category. Source: INEC census data from 1990, 1998, 2001, and 2006

Civil society organizations

Over the last 20 years, civil society in Galapagos has become increasingly complex. An analysis of the establishment dates of civil society workplaces (excluding those that were established and then disappeared) – shows that their growth has been similar to that of central government organizations (Figure 4). Two features of Galapagos civil society are that 75% of the civil society organizations represent interest groups such as fishing, tourism, and conservation interests, among others, and, as Ospina (2002) indicated, many local organizations are focused on commercial interests.

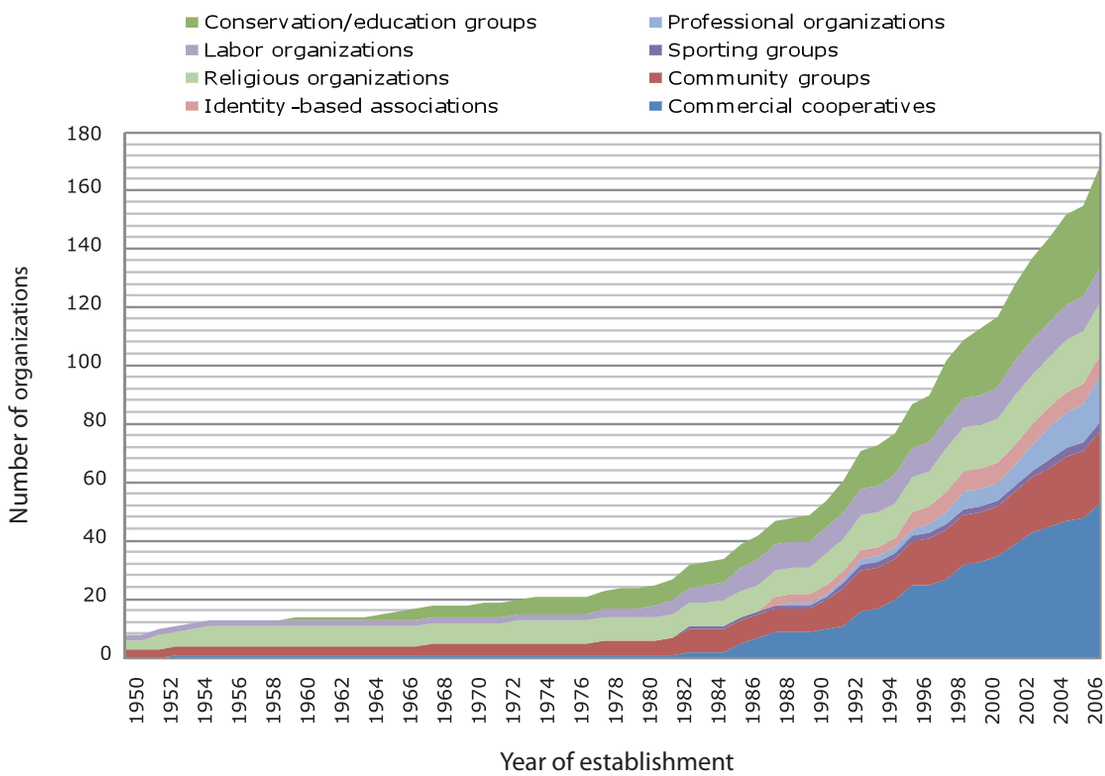


Figure 4. Number of functioning workplaces of local associations, foundations, and organizations with a physical presence in Galapagos (based on dates of establishment).

International and national non-governmental organizations

Another aspect of the organizational framework in Galapagos is the participation of international and national non-government organizations and inter-government bilateral and multilateral interests; the numbers of these organizations with offices in the islands grew from 3 in 1990 to 16 in 2006 (Figure 5). At least 60 other international and national foundations, multilateral agencies, bilateral agencies, and NGOs provide funding to Galapagos but do not maintain a physical presence in the islands.

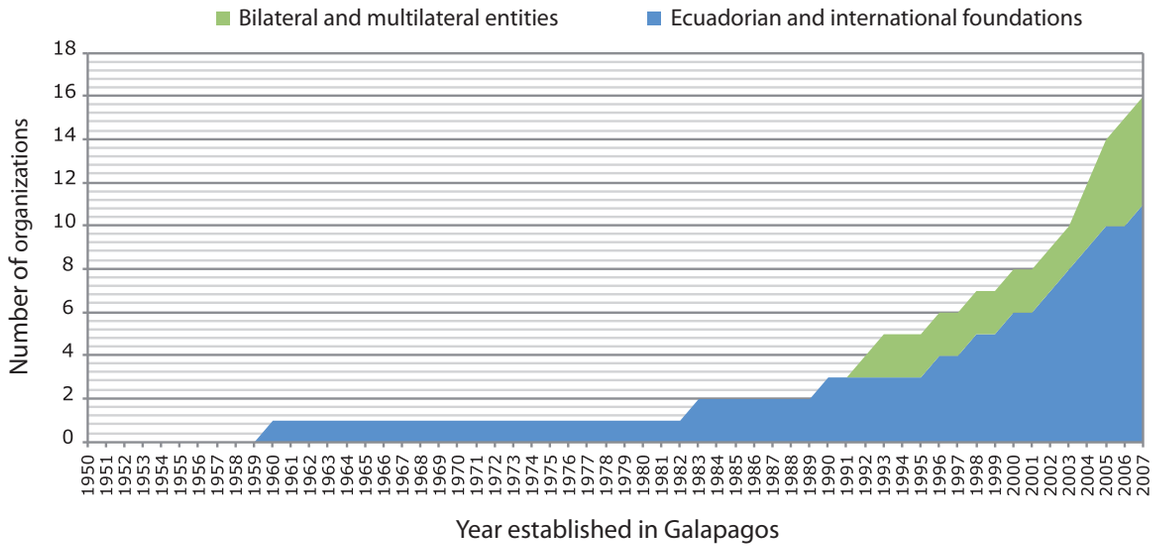


Figure 5. Number of national and international organizations and foundations with offices in Galapagos.

Observations

This analysis of organizations in Galapagos raises two questions related to the fact that the growth in the number of organizations working in Galapagos tracks the growth in the human population. Firstly, while a growing human population requires increased public services and representative structures, does this necessitate an increasing number of central government and civil society organizations? And secondly, has accountability increased with the increase in numbers of public sector and civil society organizations?

A consistently expressed concern is the overlap in competencies and replication of functions of the different organizations in the public sector and civil society in Galapagos. For example, numerous organizations[6] take decisions that affect the most important activity in Galapagos - tourism. This large number of decision-makers leaves room for alternative interpretations of policy, provides multiple routes to influence decision-making, reduces clear accountability and transparency in decision-making, and requires substantial coordination and leadership to advance towards a shared vision. In addition, there is much overlap in the actions and roles of conservation organizations.

Good governance occurs when public and private organizations are efficient and accountable to the public. Most central government organizations have websites and, by law, publish annual financial and operational information. However, during this study it was difficult to obtain financial or operational information from the public

6 President's Office, Assembly and Congress, INGALA, Ministry of Coordination of Natural and Cultural Capital, Ministry of Tourism, Provincial Directorate of Tourism, Transportes Aéreos Militares Ecuatorianso (TAME), Prefecture, Municipal Councils, Governor's Office, Participatory Management Board, National Park, Inter Institutional Management Authority, Ministry of the Environment, Port Captains, Merchant Marine, Civil Aviation, Navy, and the Ministry of Defense.

and civil society sector organizations in Galapagos. The difficulty encountered in finding annual reports from the majority of organizations in Galapagos is an indicator of weak accountability. Many civil society organizations are built around particular interests and there are arguably too few broad-spectrum organizations seeking to establish a "sense of community" in Galapagos. Galapagos seems to propagate organizations that have insufficient accountability and efficiency, and are not effectively coordinated to work toward common goals.

This analysis suggests that economic growth has forced reactively the current political and economic model rather than the model arising from effective planning. Consequently, the current organizational framework has become increasingly complicated without perhaps producing sufficient desired results in sustainable development.

Annex 1: List of organizations involved in Galapagos

Commercial organizations

Agricultural Association of Cascajo Santa Cruz
Agricultural Center of Isabela Canton
Agricultural Center of San Cristóbal Canton
Agricultural Center of Santa Cruz Canton
Association of Artisanal Fishing Boat Owners of Puerta Ayora (APROPASA)
Association of Bay and Dive Tours (Bay Tour Operators)
Association of Billiard Parlors and Bars
Association of Cattle Owners of "El Junco" San Cristóbal
Association of Cattle Owners of Isabela
Association of Cattle Owners of Santa Cruz
Association of Dive Guides of Galapagos
Association of Farm Workers of Santa Cruz
Association of Galapagos Guides (AGG)
Association of Interpretive Guides of the GNP (AGIPA)
Association of Merchant Marines for Galapagos Transport
Association of Micro Entrepreneurs of Isabela
Association of Micro Entrepreneurs of Santa Cruz
Association of Tourism Company Operators in Galapagos (ASOGAL)
Association of Tourism Operators of Galapagos (ADATUR)
Ceclilia Alvear Women's Organization (OMCA)
Constrascartin Transport Cooperative
Credit Union of the Chamber of Commerce of Quito
El Porvenir Pre-association of Farmers
Farmers Association
Fishing Cooperative of Isabela (COPAHISA)
Fishing Cooperative of San Cristóbal (COPESAN)
Fishing Cooperative of San Cristóbal (COPESPROMAR)
Fishing Cooperative of Santa Cruz (COPROPAG)
Galapagos Chamber of Tourism (CAPTURGAL)
Galapagos Islands Transport Cooperative
Galapagos Transport (TRANSGALPAS)
Galapaguera Transport Cooperative
Inter-island Maritime Transport Cooperative (CABOMAR)
Inter-island Maritime Transport Cooperative (COPESTUR)
Island Cooperative of Express Terrestrial Transport of Galapagos (CITTEG)
Island Transport Company (CITRAN)
Lava Tube Cooperative
Light Island Transport Cooperative (COTRANSLI)
Lobería Transport Cooperative
Magic Hands Pre-association
Maritime Transport of Isabela (TRANSMARTISA)
Meat and Dairy Products of Galapagos (GALACARNES)

Meat Cooperative
Mushucan Cooperative
Organization of Active Women of Isabela (OMAI)
Poultry Production Cooperative of Galapagos (COPROAVIGAL)
San Cristóbal Chamber of Tourism (CATURCRIS)
Santa Cruz Chamber of Commerce
Sierra Negra Transport Cooperative
Sierra *Piquero Patas Azules* Transport Cooperative
Submarine Marvels of Galapagos (MARSUBGAL)
The *Juntos Venceremos* Association
The *Pescado Azul* Women's Association
The *Pinzón Artesanal* Women's Organization of Isabela (OMPAI)
Tourism Association of Isabela
Union of Fishing Cooperatives of Galapagos (UCOOPEPGAL)

Community organizations

Association of Clients of the República del Ecuador Hospital
Don Jorge Foundation
Galapagos Scout Group
Neighborhood Associations
Pioneers of Galapagos Association
Youth Council

Local conservation organizations

Albatross Ecological Foundation (Fundación Ecológica Albatros)
Foundation for Responsible Alternative Development (FUNDAR)
Foundation for the Ecological Defense of Galapagos (FEDEGAL)
Independent Environment (Ambiente Independiente)

International and national foundations

Charles Darwin Foundation
Conservation International
Ecology Project International
Foundation for the Future of Latin America (Fundación Futuro Latino Americano)
Foundation for the Promotion and Support of Development (IPADE)
Galapagos Foundation
Jatun Sacha Foundation
Red Cross
Sea Shepherd
Wild Aid
World Wide Fund for Nature

Sports organizations

County League of Santa Cruz
Neighborhood League
Sports Federation of Galapagos
Surfing Club
Triathlon of Santa Cruz

Educational centers and organizations

Alejandro Humboldt Superior Technical Institute
Catholic University of Guayaquil
Don Bosco Distance Learning High School
Drops of Hope Foundation (Fundación Gotitas de Esperanza)
Equinos Technical University

Fray Agustín de Azkunaga High School
Immerse-Connect-Evolve Foundation (ICE)
Loma Linda Adventist School
Montessori School
New Era for Galapagos Foundation (Fundación Nueva Era Galápagos)
Pedro Pablo Andrade Educational Unit
Private Technical University of Loja
Private Technical University of Loja Isabela
Prometheus Foundation
Runakunapak Yachay School
San Francisco de Asis Educational Unit
San Francisco University of Quito (GAIAS)
Scalesia Foundation
Tomas de Berlanga School

Professional organizations

Artists Association of San Cristóbal
Association of Galapagos Journalists
Association of Galapagos Professionals
Association of Isabela Artisans
Bakers Association
Builders Association
Cabinet Makers Guild of Santa Cruz
Carpenters Guild of Santa Cruz
Ecological Artisan Park Guild
Foundation for the Support and Commercial Development of Artisans of Ecuador
Las Palmas Inter-professional Artisans Association
Masters and Masons Guild
Masters and Operators Association
Mechanics Guild of Santa Cruz
Ships Carpenters Guild of Santa Cruz
Tailors and Dressmakers Association
Woodcarvers Guild

Identity groups

Association of Esmeraldeños
Association of Lojanos
Association of Orences
Association of Salacas
Association of Salasacas Nucanchi Llacta Salasaca "Nuestro Pueblo"
Community of Salasacas
Organization of Salasacas Residing in Galapagos

Religious organizations and churches

Assembly of God
Catholic Church
Church of Christ MI-EL
Church of God
Franciscan Missions
Hosanna Christian Center
Jehovah's Witnesses
Name of Jesus Evangelical Apostolic Church
Pentecostal Church

Employer and employee organizations

Association of INGALA Employees

Association of Municipal Employees
ElecGalapagos Workers Union
Hospital República del Ecuador Union
Municipal Employees Union
Municipal Workers Union
National Teachers Union
Professional Drivers Union

Central government organizations

Board for the Protection of Children's Rights
Central University of Ecuador
Civil Aviation Directorate
Civil Court
Civil Defense
Civil Register
Criminal Court
Deputy Political Officials
Ecuadorian Agricultural Health Service (SESA) - Galapagos Quarantine and Inspection Service (SICGAL)
Ecuadorian Air Force in Galapagos
Ecuadorian Institute for Social Welfare (IESS)
Ecuadorian Institute of Social Welfare (IESS) hospitals
Environmental Police
Fire Department
Fuel company (Petrocomercial)
Galapagos Electric Company (ElecGalapagos)
Galapagos National Park
General Accounting Office of the State
Governor's Office of Galapagos
Guayaquil University (Fabricio Valverde Laboratory)
INGALA Council
Inter-institutional Management Authority (AIM)
Internal Revenue Service
National Development Bank
National Fisheries Institute
National Institute of Children and Families
National Institute of Children and Families Center for Integrated Development in San Cristóbal
National Institute of Galapagos (INGALA)
National Office for the Eradication of Malaria
National Police
Naval School Education Unit
Notary Publics
Office of Ecuadorian Culture
Oscar Jandl Hospital San Cristóbal
Participatory Management Board (JMP)
Police Commission
Political Bosses
Port Captaincies
Post Office of Ecuador
Primary Schools
Phone company (Pacifictel)
Provincial Election Tribunal of Galapagos
Provincial Office of Agriculture in Galapagos
Provincial Office of Economic and Social Inclusion
Provincial Office of Education
Provincial Office of Education – Santa Cruz Division
Provincial Office of Health
Provincial Office of Social Welfare
Provincial Office of Telecommunications
Provincial Office of the Ministry of Urban Development and Housing
Provincial Office of Tourism

Provincial Transportation Board
Public Defenders Office
Public Prosecutors Office
Regional Office of the Island Merchant Marine
República del Ecuador Hospital
Satellite Health Center in Isabela
Second Naval Zone Command
Secondary Schools
TAME Airlines

Local government organizations

Consortium of Municipalities of Galapagos
County Councils for Children and Adolescents
County Health Councils
County Tourism Councils
Inter-institutional Centers for the Management of Invasive Species
Invasive Species Control Unit of Isabela
Municipal Governments
Municipal Schools
Provincial Government of Galapagos
Provincial Representatives
Town Councils

Bilateral and multi-lateral donors

Araucaria XXI (Spanish government; Spanish Agency of International Cooperation)
E8 (Energy companies of the G8): United Nations Development Program
Global Environment Facility (United Nations Development Program)
Japanese International Cooperation Agency (JICA)
ProINGALA (Italian government; United Nations Development Program)

General characteristics of the tourist fleet in Galapagos and its compliance with environmental standards

Mario Piu Guime & Edgar Muñoz H.

BID FOMIN-CAPTURGAL

There are 84 tourist boats registered with the Galapagos National Park Service (GNPS) (Annex 1). These vessels are classified into four groups according to their Gross Registered Tonnage (GRT)[1] (Figure 1). The sum total of GRT for the fleet is 30 573 tons. Although large boats over 400 GRT make up only 13% of the fleet, these few vessels account for the majority of the GRT.

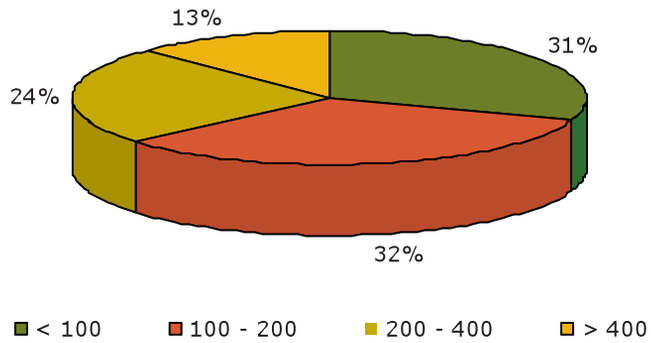


Figure 1. Percentage of vessels by Gross Registered Tonnage (GRT). Source: GNP.

The 84 vessels in operation have a combined capacity for 1 834 passengers[2], with 37% of the available berths in the 11 largest ships and the remaining 63% in the 72 tourist boats with a GRT less than 400 (Table 1).

Table 1. Data on maritime tourist operations by vessel class.

Vessel characteristics	Vessel class according to GRT				
	< 100	100 - 200	200 - 400	> 400	Total
No. of vessels	22	29	21	11	**83***
% of vessels	27	35	25	13	100
Total GRT	1230	4235	5467	19641	**30573**
% total GRT	4	14	18	64	100
No. of passenger berths	328	464	368	674	**1834**
% total passenger berths	18	25	20	37	100

* Only 83 of the 84 tourist vessels registered with the GNP are listed here; during the study, one vessel was out of operation. Source: GNP

1 Gross Registered Tonnage (GRT): The total volume of the enclosed space on a ship (excluding the ballast tanks), expressed in Moorson tons (MT). It is used to calculate different payments of operation.
2 Does not include crew berths.

The tourist fleet and environmental standards[3]

A diagnostic study undertaken in October and November 2007, with a sample of 63 vessels, evaluated the principal environmental management areas: solid waste treatment, black water, ballast water, measures to reduce environmental impacts, reduction of risks of introduced species, socioenvironmental commitment, and onboard management systems.

An analysis of the level of compliance for each management area by the four groups of vessels based on their GRT shows that in general the large ships have a higher level of compliance, but the range of compliance is wide in all groups (Figure 2). In general the areas with the greatest level of compliance are solid waste treatment and mechanisms to reduce the risk of introduced species.

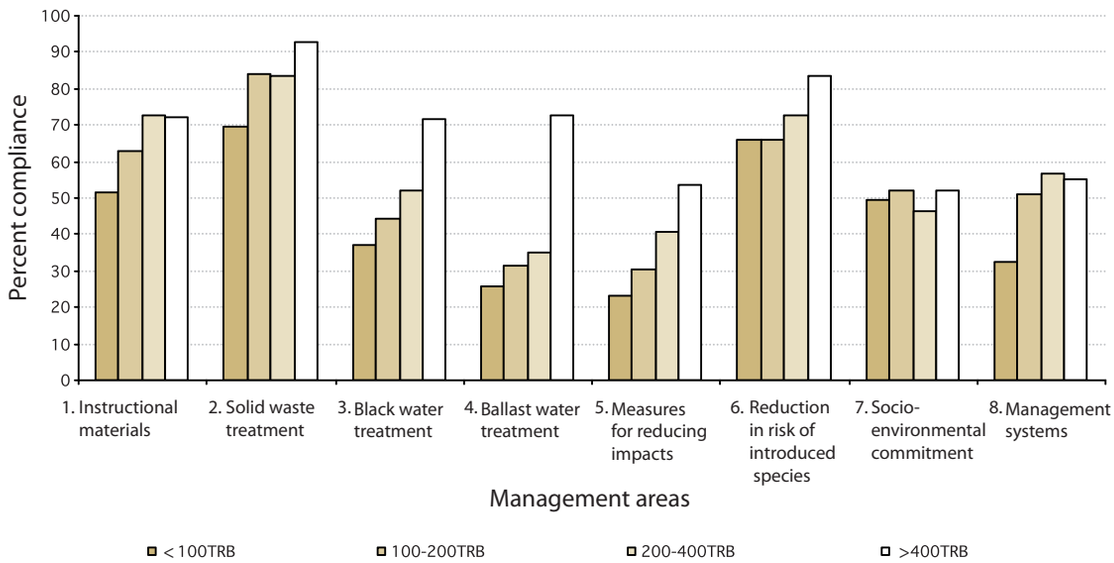


Figure 2. Percent compliance by the tourist fleet for environmental management areas by range of GRT.

The management area with the highest level of implementation onboard tourist vessels is solid waste treatment, with a minimum of 70% of the vessels in compliance (Table 2). The second area of highest compliance is reduction of the risk of introduced species (minimum of 65%), principally through the use of yellow lights on deck and permanent and certified fumigation systems. The criteria related to whether a vessel has an inspection and quarantine system for storage of products onboard was partially covered for those operations whose fresh produce comes from the continent and passes through the normal health inspections of the Quarantine Inspection System for Galapagos (SICGAL).

Systems for treating black water and ballast water and measures to reduce general environmental impacts were the three areas with the lowest level of implementation (Table 2), especially among the three groups of vessels with less than 400 GRT. The majority of these ships do not have approved and certified treatment systems for black water nor do they have filtering systems to separate the oily ballast water. As a result, water is discharged into the sea without treatment.

The majority of operations indicated that their discharges are done manually while the vessel is underway, before or after arriving at visitor sites or anchorages. However, it is relatively difficult to verify if they discharge at a distance of 12 miles from the coast (for non-treated and unseparated black water) and of three miles (when they treat the water according to the Flag Rules). Some operations have developed mechanisms to separate and disinfect black water before discharging

3 Environmental standards for tourist boats in Galapagos selected for review in this study include the combination of requirements and technical specifications that are required to operate in Galapagos, established under applicable national legislation and international agreements to which Ecuador is a signatory.

them into the sea, although these methods have not been approved or certified by the International Maritime Organization (IMO) or the Ecuadorian Marine Authority.

The other area with low implementation is related to efforts to reduce overall environmental impacts. The majority of criteria used to examine this could be considered "good practices," given that they are not obligatory requirements. The most frequent actions in this category include: (i) possession and implementation of an engine maintenance plan; (ii) water treatment using a technique that is not harmful to the environment (reverse osmosis, filtration, ozonification, etc.); (iii) use of four-cycle engines for the dinghies, and (iv) use of water and energy conservation measures. Thirty-seven percent of the boats use biodegradable cleaning products on a regular basis, with an additional 12% using them occasionally. Four operators have carried out their own studies to identify negative impacts of their operation and have action plans to reduce those impacts. None of the vessels have a renewable energy system.

Table 2. Percent implementation of environmental action areas by the Galapagos tourist fleet.

Practice	Percent
Solid waste treatment	70
Minimization of transport of introduced species	65
Use of biodegradable products	12-37
Renewable energy systems	0
Socioenvironmental commitment	46-52
Participation in conservation activities of GNP or CDF	35
Guide training	12-17
Quality service for clients	8-21

In the areas of social and environmental stewardship, the percent of action among the four groups of vessels is very similar, with a range of 46 to 52% implementation. The criteria for this area include employment policies consistent with best practices and regional regulations. In general, the majority of the fleet contracts local employees with legal residence in Galapagos. However, this is less true of the vessels larger than 400 GRT.

In respect to some kind of participation in activities that support the conservation work of the GNP or the Charles Darwin Foundation (CDF), 35% gave a positive response. In relation to training of naturalist guides, 17% indicated that they have some general system of training but not directly related to the environment, and an additional 12% indicated that the training is only partial. Twenty-one percent of respondents indicated they have a system in place to assure client satisfaction and high quality customer service and 8% indicated they are in the process of establishing one.

Two criteria were established regarding management systems and best practices. The first involves security and prevention of pollution using the Safety Management System (ISM code). Eighty-six percent of the vessels are certified in this area, which is obligatory for all passenger vessels. The second criterion is related to environmental actions or best practices, which are voluntary measures. Ten percent of the vessels have an Environmental Certificate and one is in process of certification.

Discussion

Currently, the tourist fleet of Galapagos, taken in aggregate, is deficient in its environmental compliance and is even less active in ensuring best environmental practices in areas that are unregulated.

The tourist fleet of Galapagos, taken in aggregate, is deficient in its environmental compliance and is even less active in ensuring best environmental practices in areas that are unregulated.

These conclusions are due to the fact that certain environmental requirements such as those included in Annex IV of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) to avoid contamination by black water was

only recently enacted mid 2007. The ban on the use of anti-fouling paints containing tin was implemented on January 1, 2008, while the requirements to prevent air pollution (nitrates and sulfates) are not yet in force in Ecuador.

For more than two decades, the Maritime Authority, charged by the Ecuadorian government to administer and ensure the implementation of the regulations of the International Maritime Organization (IMO), has delegated this responsibility and the overall process of Review and Certification of Vessels to national certification agencies. In addition, a large portion of the regulations that the Maritime Authority issued were legally challenged by the maritime community under the constitution. The challenges were based on the belief that the regulations should only be applied to those who are not affected economically and that fewer regulations should exist (X. Mancheno, pers. com.).

The high rate of compliance with solid waste treatment regulations is probably due to the Safety Management System and Pollution Prevention (ISM Code) that were initiated in Galapagos in 2000, and to parallel institutional efforts to establish an Integrated Management System for Solid Waste in Santa Cruz. The other systems such as treatment of black water and oily ballast water have not yet been implemented in the majority of vessels, although this is an obligatory requirement according to the MARPOL 73/78 Convention signed by Ecuador, and recently incorporated into the Flag Rules – Galapagos Version, drafted in Puerto Ayora by the maritime authorities and tourist boat operators in May 2007.

The agreement of May 2007 established a timeframe for passenger ships up to 400 GRT or up to 36 passengers to install approved and certified black water treatment equipment, with a final deadline of the first of January 2010. In respect to filtering systems for oily waters, the agreement states that all ships of 400 GRT and passenger boats under 400 GRT must install an approved hydrocarbon filtering system and must ensure that discharges into the sea do not exceed 15 ppm; this requirement does not have a deadline.

Another agreement included in the Flag Rules is that after January 1, 2008, all ships that operate in the Marine Reserve and the Especially Sensitive Zone of Galapagos must certify that they use a tin-free anti-fouling treatment. The agreement achieved in the Flag Rules – Galapagos Version, which includes requirements currently adopted by Ecuador as well as others included in International Conventions, is considered an important achievement for Galapagos.

Conclusions

It is imperative that a process be undertaken to ensure that the tourist fleet of Galapagos complies with basic environmental norms and standards in the short to mid term. This process should include incentive mechanisms to promote the adoption of best practices, whether they are included in management regulations or not, so that tour operators offer a more attractive product, which is more profitable and minimizes environmental, social, and economic impacts.

Criteria related to best practices or the development of environmental management systems through certifications has not been developed for the entire fleet. Few vessels have their environmental certification and others are in the process of obtaining one. The certification of the Safety Management System and Pollution Prevention (ISM Code) is an important advance and nearly all of the tourist vessels have obtained one.

The environmental categorization of tourist vessels should focus first on improving compliance levels for the entire fleet in order to achieve basic environmental standards across the board. An incentive mechanism must also be used to encourage the operators to move from mere compliance with an environmental "check list," to maintaining their operations based on certified environmental management systems. This will ensure that the principal source of economic revenues for the province is aligned with the fragile nature of Galapagos.

Annex 1. Vessels registered for operation with the Galapagos National Park.

Nº.	VESSEL	Passengers	GRT (MT)	Length	License Number
1	AIDA MARIA	16	100.13	19.53	TN-01-0080
2	ALBATROS	14	135.93	30.70	TN-01-0154
3	ALTA	16	211.83	6.70	TN-001-0100
4	AMAZONIA	16	94.72	22.00	TN-01-0228
5	AMIGO I	16	113.00	19.38	TN-01-0905
6	ANAHI	16	221.23	27.40	TN-01-0221
7	ANGELIQUE	16	103.60	22.50	TN-01-0162
8	ANGELITO I	16	152.83	22.03	TN-01-0076
9	ARCHIPELL II	16	200.32	26.00	TN-01-0933
10	ATHALA II	16	319.50	29.97	TN-01-0988
11	ATLANTIDA II	16	24.62	13.30	TN-01-0164
12	BELUGA	16	227.67	33.35	TN-00-00336
13	CACHALOTE	16	92.5	25.86	TN-01-0116
14	CARINA	16	258.7	29.64	TN-00-0445
15	CHATHAM	16	30.49	14.79	TN-01-0939
16	CORAL I	36	359.33	39.00	TN-00-0151
17	CORAL II	20	2 890.00	91.50	TN-00-00477
18	CORMORANT II	16	221.27	27.44	TN-01-0226
19	CRUZ DEL SUR	16	169.92	23.65	TN-01-0914
20	DAPHNE	16	148.75	20.75	TN-01-0004
21	DARWIN	16	127.40	18.64	TN-01-0026
22	DEEP BLUE	16	223.30	30.65	TN-01-0924
23	DIAMANT	16	57.31	26.40	TN-01-0081
24	ECLIPSE	48	1 610 .00	63.87	TN-00-00425
25	EDEN	16	154.5	25.40	TN-01-0124
26	ENCANTADA	10	78.01	21.44	TN-00-00111
27	ERIC	20	237.5	24.95	TN-00-00123
28	ESMERALDAS III	20	22.15	11.02	TN-01-0094
29	ESPAÑOLA	16	28.54	12.58	TN-01-00035
30	ESTRELLA DE MAR	16	150.00	22.80	TN-01-0911
31	EVOLUTION	32	654.94	57.20	TN-01-0166
32	FLAMINGO	12	61.15	14.75	TN-01-0012
33	FLAMINGO I	20	241 00	24 80	TN-00-00128
34	FLOREANA	16	111.17	22.20	TN-01-0917
35	FRAGATA	16	191.77	23.00	TN-01-0169
36	FREE ENTERPRISE	20	147.07	30.97	TN-01-0092
37	GABY I	16	128.15	21.35	TN-01-0055
38	GALAPAGOS ADVENTURE	16	171.31	26.75	TN-01-0065
39	GALAPAGOS ADVENTURE II	16	127.32	22.66	TN-01-0112
40	GALAPAGOS EXPLORER II	100	4 077.00	88.16	TN-00-0427
41	GALAPAGOS LEGEND	100	2890.00	91.50	TN-00-00477
42	GALAPAGOS VISION I	10	36.49	14.80	TN-00-00154
43	GALAXY	16	255	11.73	TN-06-3397
44	GOLONDRINA I	14	65.78	20.22	TN-01-0015
45	GUANTANAMERA	16	140.40	22.40	TN-01-0008
46	INTEGRITY	16	318	42.48	TN-01-0066
47	ISABELA II	40	1 025.00	55.94	TN-00-00132
48	ISLANDER	48	1 021.66	49.90	TN-00-0481
49	JESUS DEL GRAN PODER	14	135.93	29.95	TN-01-0156
50	LAMMER LAW	18	142.2	26.20	TN-01-0063

Annex 1. Continuation

Nº.	VESSEL	Passengers	GRT (MT)	Length	License Number
51	LETTY	20	234.57	25.96	TN-00-00131
52	LIBERTY	16	160.78	20.15	TN-01-0071
53	LOBO DE MAR III	16	162.37	25.50	TN-01-0107
54	MARY ANNE	16	395.27	52.82	TN-01-0213
55	MERAK	8	24.30	14.50	TN-01-0048
56	MILLENIUM	16	427.26	25.00	TN-01-0122
57	MISTRAL II	16	90.53	20.37	TN-01-0005
58	MONSERRAT	16	151.00	26.50	TN-04-00273
59	MONSERRAT II	16	209.07	27.75	TN-02-0010
60	NEMO MARTINICA	12	51.76	25.00	TN-01-0225
61	PARRANDA	16	211.72	37.89	TN-01-0096
62	PELIKANO	16	121.21	20.15	TN-01-0043
63	POLARIS	80	2 138.00	72.00	TN-00-00360
64	QUEEN OF GALAPAGOS	16	307.00	29.60	TN-01-0962
65	REINA SILVIA	16	165.34	24.40	TN-01-0224
66	SAGITTA	16	252.14	32.05	TN-01-0110
67	SAMBA	14	134.13	23.70	TN-01-0109
68	SAN JOSE	16	304.71	33.00	TN-01-0904
69	SANTA CRUZ	90	1 675.00	69.50	TN-00-0136
70	SANTA FE II	20	31.05	13.65	TN-01-0054
71	SEA CLOUD	10	23.53	11.30	TN-01-0178
72	SEA FINCH	20	72.93	18.85	TN-01-0217
73	SEA MAN	16	127.29	23.60	TN-01-0910
74	RUMBA *	10			
75	SKY DANCER	16	205.83	32.72	TN-00-00422
76	SPONDYLUS	16	151.75	24.67	TN-01-0207
77	SULIDAE	16	60.53	20.46	TN-00-00120
78	THE BEAGLE	16	93.19	27.25	TN-01-0111
79	TIP TOP II	16	109.54	26.00	TN-01-0039
80	TIP TOP III	16	200.25	29.90	TN-01-0108
81	TIP TOP IV	16	252.19	38.26	TN-01-0212
82	VERITO	16	19.20	10.75	TN-01-0105
83	XPEDITION	100	2 842.00	88.50	TN-00-0459
84	YOLITA I	16	71.56	16.00	TN-01-0009

*** Not in operation at the time of this study**

The Galapagos National Park entrance fee: A global perspective and options for the future

Reyna Oleas, M.B.A.

Introduction

In the case of protected areas such as the Galapagos National Park (GNP), the entrance fee reflects management policies established by the regional authorities and should also consider similar products in the market (primarily other national park in the case of Galapagos), the cost of maintaining the protected area, and the willingness of visitors to pay for visiting the area. Determining the entrance fee for the GNP has implications that go beyond funding for the Galapagos National Park Service (GNPS) and other institutions. It has management implications related to the number of visitors that the protected area can receive, taking into consideration both the impact of visitors on the protected area as well as the socioeconomic effect these visitors have on both the protected areas and the inhabited areas of the archipelago.

The aim of this study was to evaluate the feasibility of increasing the GNP entrance fee based on: 1) the market, through an evaluation of global, national, and local trends in tourism; 2) the client, through a study of the market and client willingness to pay the GNP entrance fee; 3) the management costs of the GNP and the other beneficiary institutions receiving a portion of the entrance fee, and 4) competition from protected areas in other parts of the world.

Current use of the Galapagos National Park entrance fee by beneficiary institutions

The Special Law for Galapagos of 1998 established six institutions that receive a portion of the park entrance fee (Table 1). The GNPS, the institution responsible for managing the PNG (97% of the land area of the archipelago, 799 540 ha) and of the Galapagos Marine Reserve (GMR, 13 800 000 ha), receives 45% of the fee. The remaining 3% of the land, which includes both public and private property, is under the jurisdiction and management of a series of institutions. Some of these institutions receive the remaining portion of the entrance fee to the GNP.

The revenue produced from the collection of entrance fees to the GNP has increased significantly in recent years along with the number of tourists, from US$5.5 million in 2002 to US$10 million in 2007 (Table 1). The revenues received by the beneficiary institutions nearly doubled from 2002 to 2007.

Table 1. Revenues received (US$) annually by the beneficiary institutions from the collection of entrance fees to the GNP from 2002 to 2007 (data in 2007 through November).

BENEFICIARY INSTITUCION OF PARK ENTRANCE FEE	% of Entrance Fee	2002	2003	2004	2005	2006	2007	TOTAL
Galapagos National Park	40	2 222 739	2 443 055	3 024 610	3 454 226	3 887 255	4 007 822	19 039 706
Municipalities	25	1 389 212	1 526 909	1 890 381	2 158 891	2 429 534	2 504 888	11 899 816
Provincial Council	10	555 685	610 764	756 153	863 556	971 814	1 001 955	4 759 926
Marine Reserve	5	277 842	305 382	378 076	431 778	485 907	500 978	2 379 963
INGALA	10	555 685	610 764	756 153	863 556	971 814	1 001 955	4 759 926
SESA SICGAL	5	277 842	305 382	378 076	431 778	485 907	500 978	2 379 963
Ecuadorian Navy	5	277 842	305 382	378 076	431 778	485 907	500 978	2 379 963
TOTAL	100	5 556 847	6 107 637	7 561 525	8 635 565	9 718 137	10 019 554	47 599 265
% increase in US$ with respect to the previous year			10	24	14	13		
Number of visitors		77 571	91 345	108 934	121 676	145 229		
% increase in number of visitors with respect to previous year		6	11	19	12	19		

Source: Galapagos National Park, 2007

The Special Law for Galapagos indicated that the funds should be used for the following purposes:

1) Education, sports, health, and environmental health projects;
2) Environmental services, and
3) Services directly related to tourism.

The following information includes data from three of the six beneficiary institutions: the National Institute of Galapagos (INGALA), the Ecuadorian Agricultural Health System and Quarantine Inspection System for Galapagos (SESA-SICGAL), and the GNPS. The other three institutions (Municipal and Provincial Governments and the Navy) did not provide the requested information.

The Galapagos National Park Service, which receives 45% of the entrance fee for the management of the GNP and the GMR, finances 45% of its budget with the resources from the entrance fee. Financial projections of the GNP and the GMR indicate that they will require an increase of 32% above the amount currently received annually from the entrance fees over the next five years, with the majority of these additional resources used to strengthen tourism management and management of the GMR.

INGALA, which receives 10% of the park entrance fee, finances approximately 30% of its budget from this source. Historical information (2004-2007) indicates that INGALA has spent approximately 77% of the resources received in activities established by the Special Law and 23% in other activities, including telecommunications, internet system, and restructuring processes, among others, most of which could be considered directly related to the permitted activities.

The financial information provided by INGALA indicates that their annual financial needs for the next three years require a 100% increase above the funds currently received from the park entrance fee.

SESA SICGAL, which receives 5% of the park entrance fees collected, finances approximately 70% of its budget from this source. Historical information (2004-2006) indicates that SESA SICGAL has spent

these funds in two main areas: personnel (89%) and operational costs (11%). The projected annual budgets for 2009-2012 are nearly five times greater than the amount currently received from the park entrance fee.

If the institutional project of controlling invasive species is considered an environmental service in accordance with the Special Law, the majority of the operational costs should not be financed exclusively from the revenues generated by park entrance fees (paid for by tourists). These costs should be assumed by other stakeholders who import goods and services for local consumption (residents, local businesses, etc.). The lack of analysis of the origin of the costs creates complex subsidies that distort the truth.

Ensuring that the funds are used efficiently, effectively, and according to law is critical. Currently there are no existing procedures or protocols within the INGALA Council for audits and annual reporting by the institutions that benefit from the entrance fee. This study highlights the need to establish such a system and to ensure an efficient and effective use of these resources.

During the last five years, the revenues received by institutions benefiting from park entrance fees have nearly doubled. This increase is directly linked to the increase in tourism and the Galapagos economy. If the number of tourists continues to increase at the current rate and the local population continues to increase in response to the demand for labor, the demands placed on institutions responsible for the welfare of the population will also grow. However, it is not clear to what extent additional financial resources are required versus the extent to which the institutions need to improve the efficiency with which they use the currently available funds.

The client: ability and willingness to pay the park entrance fee

Market opinion polls show that 95% of foreign tourists that travel to Galapagos do so because they are attracted by the unique flora and fauna of the archipelago, because they want to see what Charles Darwin saw, because of recommendations from others, or to see the islands before conditions deteriorate (Figure 1). It is clear that the greatest competitive advantage of Galapagos is its natural capital. Only 1.4% indicated they were interested in learning about the people living in the islands and none of these individuals selected that as their primary reason. Of the 4.4% who responded that their visit was due to other reasons, SCUBA diving was the principal reason; however, this is also related to the uniqueness of Galapagos and its geology and biodiversity.

Most travelers (87%) know that a park entrance fee exists. However, only 30% of those surveyed knew the destination of those funds. Those surveyed indicated that they would be amenable to paying

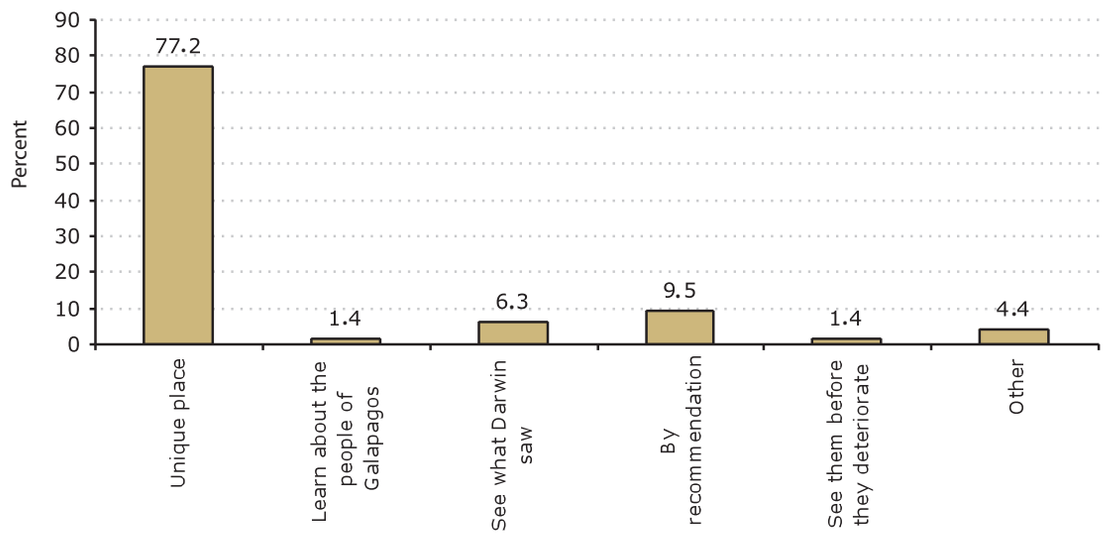


Figure 1. Principal reasons that foreign tourists visit Galapagos.

more than the established rate if they knew how the funds were used and/or if the funds were dedicated to the conservation of the islands.

Eighty-three percent of the tourists prefer one single entrance fee per visit regardless of the number of days spent in the islands. The remaining 17% would prefer paying a daily fee for the time they spend in the islands.

Nearly 60% of the tourists were willing to pay more than the current entrance fee to support conservation efforts. Of these travelers, 66% were amenable to paying an entrance fee of US$150 to US$200.

The analysis confirms that based on the picture of the market taken between October and November 2007, the park entrance fee could be doubled without negatively affecting the revenues actually

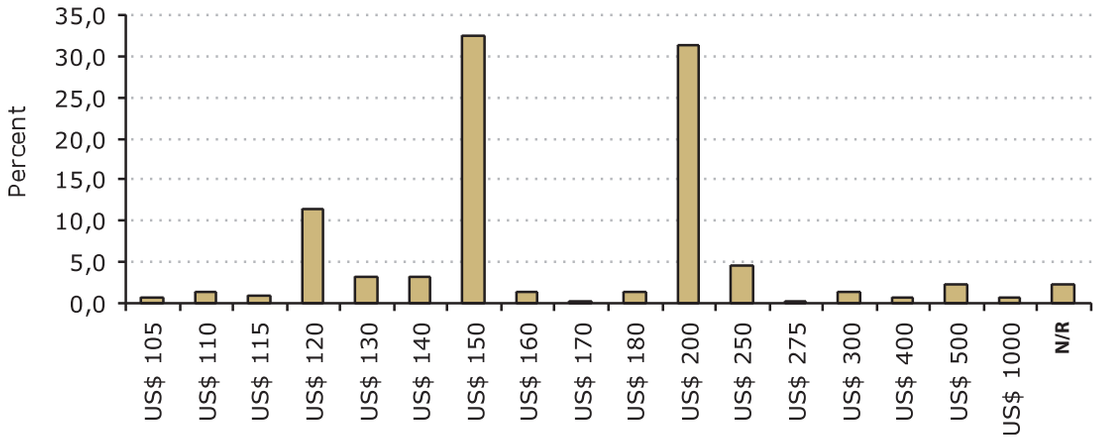


Figure 2. Percent of respondents willing to pay specific values for the entrance fee to the Galapagos National Parks. N/R = no response.

received. The supposition is that the increase in entrance fee would reduce the number of tourists, but that the additional revenue would more than make up for that drop. However, studies of willingness to pay such increases carried out in other national parks in the world demonstrate that the subsequent decrease in demand remains in effect for a limited period of time. After a few months in areas of high tourist interest, the demand returns to an amount equal to that prior to the increase of the entrance fee. This same scenario played out in Galapagos when the entrance fee was raised to its current amount.

The competition

The surveys indicated that 32% of those polled had no alternative destinations because Galapagos was one of the places that they had always wanted to visit. The results did indicate that the primary destinations that provide some competition for Galapagos are: 1) Peru and Macchu Pichu (22.1% of those surveyed); 2) African countries such as Kenya and Tanzania (13.9%); 3) other sites in Ecuador (16.3%), and 4) Antarctica (3.5%) and Australia (3%). Many of the mentioned sites do not have an entrance fee.

A review of entrance fees to other national parks in other countries indicate that Tanzania is the country whose National System of Protected Areas registers the highest entrance fees (Gombe has a daily fee of US$100, Mahale US$80 per day, Serengeti US$50 per day, and Mount Kilimanjaro US$60 per day).

The average entrance fee to national parks in Kenya is US$40 per day. The national system of protected areas in South Africa has lower entrance fees (US$13 and $18 per day). All of the mentioned fees are for adult foreign tourists. In most of the cases there are significantly lower fees for nationals and children.

In comparison to the African park experience, the average daily rate for Galapagos visitors is US$14.28, given an average stay of seven days, or US$25 per day with an average stay of four days.

However, a further analysis of the prices in Africa shows that the majority of

national parks are visited for an average of two to four days and that a large percentage of tourist packages offer 15-20 day tours, which visit between four to seven separate areas. Also, Gombe Stream and Mahala National Parks, with the highest entrance fees (US$100 and US$80 per day), receive a maximum of 1000 tourists per year and an average of 800.

Future possibilities

Regulations and auditing

Because of the significant financial resources involved and the projected budget increases in future years, it is important to ensure more effective and efficient use of resources. Therefore the establishment and implementation of regulations for the use and auditing of the revenues from the park entrance fee are recommended over the short term. However, there is a general conflict of interest in the current structure of the INGALA Council, the organization that would establish these regulations, in that the audit would also be approved by the INGALA Council, whose members include beneficiary institutions that would be audited.

Park entrance fee

Results of the opinion survey suggest that the GNP should maintain a single entrance fee without regard to the number of days that a tourist remains in the islands. When considering an increase in the entrance fee, two possible options are suggested. However, it is important that no increase in the entrance fee be established until the fundamental recommendation on the use of the funds and the auditing of accounts is implemented. Economic studies (Taylor 1999, 2002, 2006) have shown both direct and indirect impacts that are generated by injections of resources into the Galapagos economy. Additional resources generated by an increase in the entrance fee could have negative effects on sustainable human development and on the conservation of the natural resources of Galapagos if the amounts of the inversion are not carefully evaluated in terms of their eventual impacts.

Option 1 for foreigners who are not residents of countries included in the Southern Common Market (MERCOSUR – Mercado Común del Sur) or the Andean Community of Nations (CAN – Comunidad Andina de Naciones):

Increase the entrance fee to the GNP to US$120 per person to cover the necessities of the beneficiary institutions.

If the reason for the increase in the entrance fee is to cover the increase in financial needs of the beneficiary institutions resulting from the increase in immigration and tourism, an increase to US$120 per tourist should be sufficient (assuming an increase in the number of tourists equal to historical rates).

However, the message sent with such an increase would be: Galapagos has increasing needs, so additional resources are required to administer the islands. This reasoning basically omits any discussion of the fundamental reasons for the growth and therefore does not contribute to solving the challenges of conservation and sustainable development of the islands. It only tries to solve the spiraling need for financing due to continued growth in population and tourism.

Option 2 for foreigners who are not residents of countries within MERCOSUR or CAN:

Increase the entrance fee to the GNP to US$200 only when this decision is accompanied by concrete actions that demonstrate firm steps to ensure the conservation of Galapagos either by management of the number of tourists that visit the islands and/or by management of both direct and indirect effects of tourism.

This option reflects the willingness to pay expressed by the majority of tourists.

If there is a substantial increase in the park entrance fee without accompanying decisions for the short and mid term that

Photograph: Cristina López

demonstrate advances in the management in the number of tourists visiting the islands and/or the management of the direct and indirect effects of tourism, Galapagos will be presenting a contradictory message to the world, simply reflecting the single intention of obtaining economic benefits from the islands.

A fundamental requirement for this scenario must be an analysis of the distribution mechanism of the additional resources since the current system has been shown to be inadequate in terms of auditing. The design of a new financial mechanism (trust fund or some other) should be based on best practices worldwide that contribute to efficient, transparent, participatory, and agile management of the economic resources that will benefit the conservation of the ecosystem and the welfare of the local population in fundamental areas such as health and education.

Recommendation for Ecuadorian and foreign resident of countries within MERCOSUR or CAN:

Maintain different fees for Ecuadorians and foreign residents of MERCOSUR and CAN countries in line with the difference in revenue per capita of Ecuadorians versus revenues per capita in the principal markets for tourism to Galapagos (United States, Great Britain, Germany, Spain, etc.).

The economic information provided by the United Nations indicates that the per capita revenue of Ecuadorians is 6% of the average revenue of visitor from the countries mentioned. In this context, if an estimate of 10% is used, an increase in the park entrance fee to US$120 for the majority of foreign visitors would result in an entrance fee of US$7.20 for Ecuadorians and foreign residents of MERCOSUR and CAN countries. If the entrance fee is increased to US$200 for foreigners, the fee for Ecuadorians and foreign residents of MERCOSUR and CAN countries would equal US$12.

Tourism in Galapagos: the tourist industry and installed capacity

Alejandra Ordóñez[1]

CAPTURGAL /BID-FOMIN

Tourism is the principal driver of the Galapagos economy. This study presents the current state of the industry in the Galapagos Islands based on the compilation and cross-referencing of field data and records of the institutions that oversee various aspects of tourism. The article reviews installed capacity, direct beneficiaries of principle tourism activities, and occupation levels of both land-based hotels and the fleet of tourist boats.

Businesses included in this study

A total of 717 businesses were studied, including 528 Direct Tourism Services (DTS), which include lodging on land, tourism boats, travel agencies, restaurants, bars, discotheques, and terrestrial transportation for tourists, and 189 Indirect Tourism Services (ITS), which include public terrestrial and maritime transport, souvenir shops, horse rentals, and rentals of dive equipment and kayaks. Data regarding these businesses were obtained through the records of various institutions (Ministry of Tourism, Galapagos Chamber of Tourism - CAPTURGAL, National Merchant Marine and Directorate for the Coast - DIGMER, Galapagos National Park – GNP, and municipal governments) and through field work in July 2007.

Of the 528 DTS businesses, 84 are registered but not currently in operation and 42 are informal businesses (not included in official records), but they are operational. This means that there are currently 444 businesses in operation in Galapagos, distributed over six subsectors (Table 1).

The principal businesses associated with direct tourism services are marine tourism transportation (33%), followed by food services (26%) and lodging (20%) (Figure 1). The other categories combined (travel agencies, recreation and entertainment, and terrestrial tourism transportation) represent 21% of Galapagos businesses. Sixty-three percent of the indirect tourism service businesses are involved in the sale of souvenirs, followed by 24% in public maritime transport and coastal shipping (Figure 2).

1 With contributions from Edgar Muñoz and Cristian Cavichiolo

Table 1. Number of businesses that provide Direct Tourism Services in Galapagos.

Type of Establishment	No. in Operation	No. not in operation	No. Informal**	Total
Lodging	89	13	6	102
Food	102	31	8	133
Travel agency	56	15	7	71
Recreation and entertainment	20	8	0	28
Marine tourism transport	168*	16	18	184
Terrestrial tourism transport	9	1	3	10
Total	**444**	**84**	**42**	**528**

* Corresponds to vessels dedicated to tourism activities, both with and without overnight facilities.
** Informal businesses are a subset of businesses in operation.

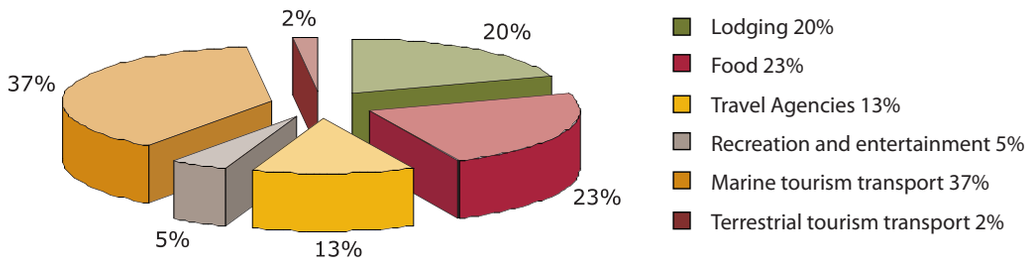


Figure 1. Distribution of Direct Tourism Services currently operating in Galapagos (N = 444).

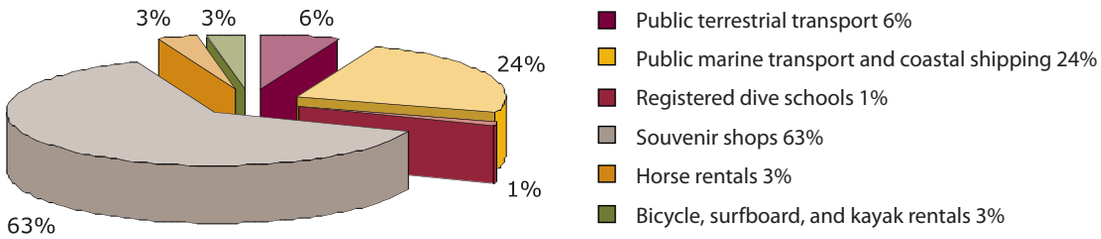


Figure 2. Distribution of Indirect Tourism Services in Galapagos (N = 189).

Most of the DTSs (221 businesses) are located in Santa Cruz, followed by 146 in San Cristóbal, and 73 in Isabela (Table 2). Floreana has only four registered DTSs. Although Isabela has fewer tourism businesses than San Cristóbal, it has more hotels. On average, the hotels in Isabela are relatively new and have been in operation an average of only six years.

Table 2. Distribution of Direct Tourism Services currently in operation by island.

Type of Establishment	Santa Cruz	San Cristóbal	Isabela	Floreana	Total
Lodging	35	22	30	2	89
Food	48	32	21	1	102
Travel agencies	34	12	10	0	56
Recreation and entertainment	7	8	5	0	20
Maritime tourism transport	94	69	4	1	168
Terrestrial tourism transport	3	3	3	0	9
Total	**221**	**146**	**73**	**4**	**444**

Direct beneficiaries of Direct Tourism Services

Tourism operations in Galapagos employ a total 3451 people (Table 5). Based on an estimate of four dependents per worker (including the workers themselves),the total number of direct beneficiaries is 13 804.The results of the most recent census (INEC, 2006) show that Galapagos has 19 184 inhabitants, thus the direct beneficiaries of tourism represent 72% of the total resident population.

Table 3. Number of beneficiaries (employees) of the different subsectors of the tourist industry.

Type of Establishment	Floreana	Isabela	San Cristóbal	Santa Cruz	Total
Lodging	4	80	57	300	441
AAVV	0	20	23	93	136
Tourist boats (office employees)	2	5	92	687	786
Tourist boats (onboard crews excluding guides)*	0	0	230	870	1100
Food	2	48	93	197	340
Bars and discotheques	0	7	14	37	58
Souvenirs	0	14	84	98	196
Terrestrial tourism transport	0	3	35	23	61
Active naturalist guides, 2007**					**333**
Total	**8**	**177**	**628**	**2305**	**3451**

* Source: Epler, 2007, **Source: PNG, 2007

A majority of jobs (53%) are connected to the tourist boats, with 31% of employees working aboard tourist ships and 22% working in supporting jobs (Figure 3). The next largest number includes hotel employees (13%), followed by naturalist guides (10%).

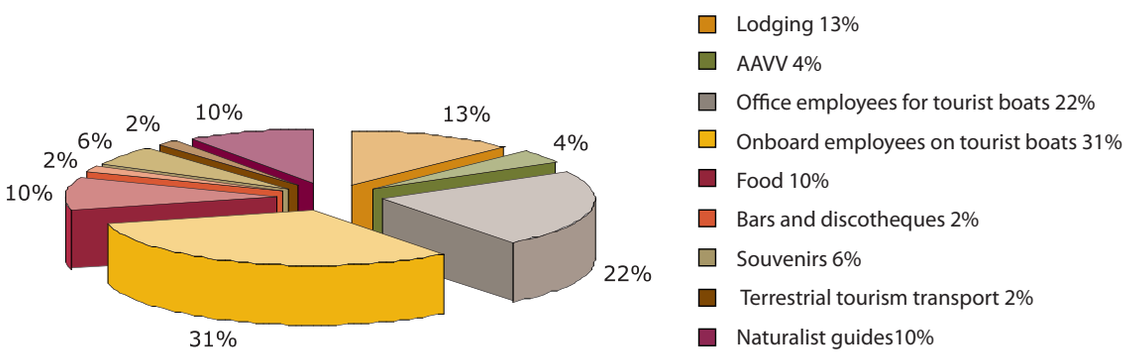


Figure 3. Percentage of employees who work directly in tourism services, by subsector.

Occupancy in land and sea lodging services

Two different types of lodging are available in Galapagos: (i) land-based hotels and (ii) tourist vessels.

Lodging on land can be profitable even with low occupancy rates because fixed costs are low, especially at hotels like those found in Isabela and Floreana. However, Floreana is not representative given that it has only two hotels, which are visited infrequently. The majority of lodging facilities in Galapagos are located in Santa Cruz and San Cristóbal. They have an average installed capacity of 31 beds distributed in approximately 14 rooms. Approximately 40% of the lodging establishments have occupancy rates lower than 50%.

Five percent of the tourist boats cannot operate successfully with occupancy rates lower than 60% due to high fixed operation costs. Some of them achieve 100% occupancy during the high season.

Data for 2007 provided by the GNP indicate that 61% of tourists entering Galapagos contract ship-based lodging while 39% remain on land. However, the capacity on land (2157) exceeds that of the tourist fleet (1876), even though the number of berths in the tourism fleet increased during the period 1996 to 2006, due primarily to the refitting of day boats to allow for overnight cruises.

Installed capacity

The installed capacity is reflected in the current total number of existing beds or berths. Currently in Galapagos there are 973 hotel rooms with 2157 beds. Most of these establishments are located in Santa Cruz, followed by San Cristóbal and Isabela (Table 3). On Floreana, there are only two hotels and the number of rooms and beds is very low in comparison with the other islands. Although Isabela has eight more lodging establishments than San Cristóbal, the installed capacity in San Cristóbal is greater due to the fact that many of these hotels provide a more urban model of lodging to support visitors conducting business in the provincial capital.

Table 3. Total capacity in the Direct Tourism Services by island.

Island	Hotels		Vessels with overnight accommodations	Vessels without overnight accommodations	Food		Drinks (bars and discotheques)
	No. of rooms	No. of beds	No. of berths	No. of seats	No. of tables	No. of seats	No. of seats
Floreana	21	42	0	10	6	30	0
Isabela	159	357	0	38	132	561	102
San Cristóbal	285	630*	304	506	239	1037	214
Santa Cruz	512	1128	1572	352	491	1714	331
Total	**973**	**2157**	**1876**	**906**	**868**	**3342**	**647**

* An additional 100 beds are estimated due to the practice of individuals providing "bed and breakfast" services in their private homes (25 private homes with an approximate capacity of four tourists per house). This type of service is not regulated but interviews with tourism operators and others involved in the industry indicate that they have contracted with these people for the service.

The majority of tourist cruise boats with overnight accommodations are based in Santa Cruz, followed by San Cristóbal (Table 3). Currently none are based in Floreana and Isabela, although both islands do have a limited number of boats that provide day trips. San Cristóbal has the largest number of boats making day trips. The situation is the same for restaurants and bars, with the largest number in Santa Cruz.

Based on the installed capacity on land (2157 beds) and sea (1876 berths) and an average stay of 5.6 nights per visitor, Galapagos has a current installed capacity to receive approximately 262 865 tourists per year.

Conclusion

With an installed capacity of nearly 100 000 tourists more than the current visitation rate, one might conclude that Galapagos can easily absorb over one hundred thousand more tourists annually. This conclusion does not take into account issues of tourist satisfaction, impact on visitor sites, and absorptive capacity of municipalities to accommodate the theoretical limit – installed capacity - of tourists (water, sewage, energy, etc.). These topics have been more fully addressed in a number of reports on tourism limits and are mentioned here to indicate that decisions on tourism growth and management require a broad range of data, including economic, environmental, and sociological.

Improved integrated management of residual solids in Santa Cruz canton and the resulting decrease in solid wastes

Ulf Tosten Hardter, Ph.D.

Municipal Government of Santa Cruz/WWF

Introduction

In recent years, the resident population of the canton of Santa Cruz has greatly increased and there are currently more than 16 000 resident and temporary inhabitants.[1] The current population growth is nearly 7% per year, which is reflected in the ever-increasing generation of waste (7% per year) and demand for electricity. In addition, there is an annual floating population of 100 000 tourists that arrive in Galapagos, the majority of whom enter via the canton of Santa Cruz. The majority of tourist boats base their operations out of Santa Cruz, requiring that the provision of services to these vessels (fuel, water, food, waste management, etc.) come from this community. This high level of population growth has major implications for the local government and the provision of basic services, such as water, sewage system, garbage collection, health, and education.

With an increasing population the demand for services provided by the Municipal Government of Santa Cruz (MGSC)—especially waste management—continues to increase. Since 2006, the MGSC has relied on a new Integrated Solid Waste Management System, which is primarily supported by the World Wildlife Fund (WWF)[2]. The system includes the separation of different types of waste at the source (recyclables, organic, and non-recyclables), selective collection, and processing and/or recycling depending upon the type of waste (Hardter and Sánchez, 2007). Glass (approximately 25% of the total) is the only one of the recyclable materials that is recycled in Santa Cruz; the other 75% is transported to the continent for processing. The system also includes collection of toxic and hospital wastes, as well as separate collections of voluminous materials, such as yard waste, scrap iron, and used tires. The micro-enterprise RELUGAL (Collection of Used Lubricants

1 The estimate of 16 000 inhabitants is based on average energy and water consumption in Santa Cruz. Domestic waste generation data support the estimate.

2 WWF provides approximately 75% of the program budget. Other supporting institutions include AECI/Proyecto ARAUCARIA XXI, the Charles Darwin Foundation, and Fundación Galápagos.

in Galapagos) manages the collection and storage of used engine oils. In 2008, the system was expanded to include waste management and recycling of materials from the entire canton, including Baltra. System capacity has been designed to increase gradually with demand.

Evolution of the production of solid waste in Santa Cruz

The estimate of total production of solid waste in 2007 was based on a study of the composition of waste in 2003 (Honkish, 2003) and the estimate of production of waste per capita of 0.79 kg/resident/day (Zapata, 2005). Based on these two studies and the size of the current population, in 2007 the human population on Santa Cruz produced an average of 11 to 12 tons of waste per day.

In 2007 the human population on Santa Cruz produced an average of 11 to 12 tons of waste per day.

Results achieved: Increase in the recycling rate between 2006 and 2008

Until 2006, the separation of waste was voluntary and the average amount of recycled waste collected was 13 tons per month, with variations occurring during the system's startup period (Figure 1). Continued improvements in the system, an educational campaign carried out with support from WWF, and the implementation of a monitoring system have all contributed to the program's success. From May 2007 to May 2008, the monthly quantity of recycled material in the canton of Santa Cruz doubled from 17 tons to 35 tons.

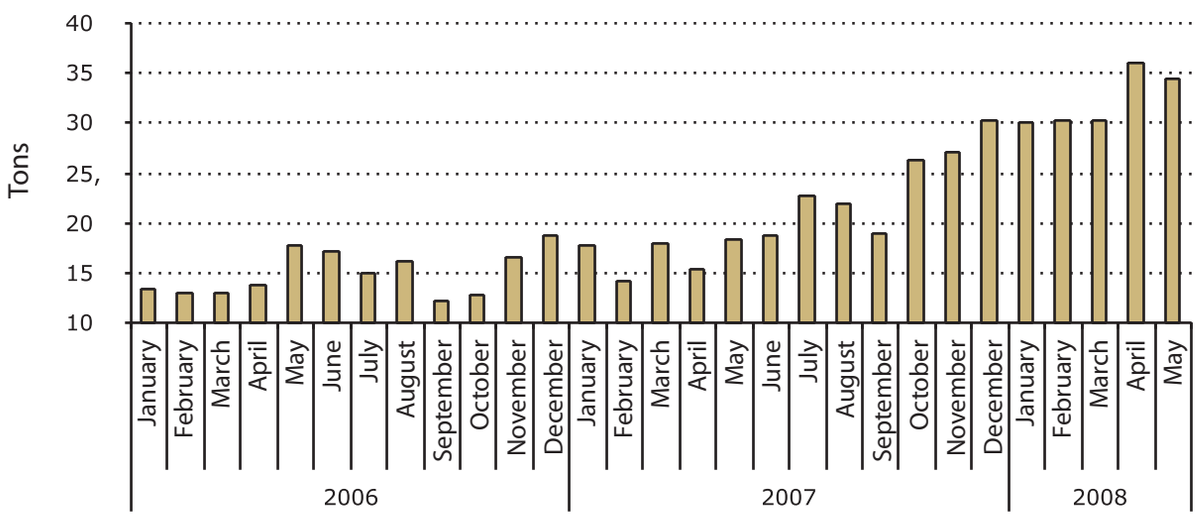


Figure 1. Monthly volume of recycled material in Santa Cruz from 2006 to 2008.

An increase in plastics, glass, and paper in 2007 and 2008 is also notable, with a 10-fold increase in plastic in just two years, while both glass and paper had a 5-fold increase.

The amount of recycled waste shipped to the continent has increased steadily from 2000 to 2008 (Figure 2). Up until 2006, more than 80% of the recycled material in Santa Cruz was cardboard. An increase in plastics, glass, and paper in 2007 and 2008 is also notable, with a 10-fold increase in plastic in just two years, while both glass and paper had a 5-fold increase.

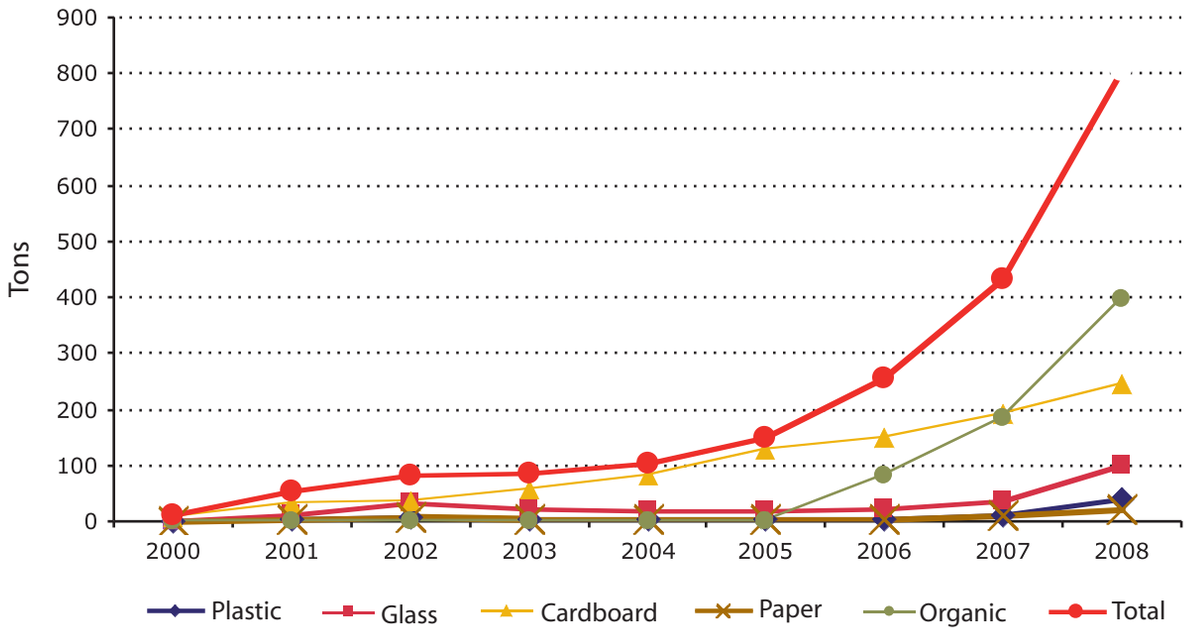


Figure 2. Annual amount of recycled materials transported from the Recycle Center to the continent or used in Santa Cruz from 2000 to 2008. The 2008 data reflect an estimate based on the results of the first five months of the year.

The quantity of organic material entering the composting plant at the Recycling Center has been measured since the beginning of January 2007 (Figure 3). The estimated amount processed in 2006 (based on volume estimates) was nine tons per month. Between May 2007 and May 2008, the monthly amount increased from 12 to 35 tons. There has been a near tripling of the amount of organic material collected and processed, primarily due to improvements in the collection system, the education campaign, and continued monitoring.

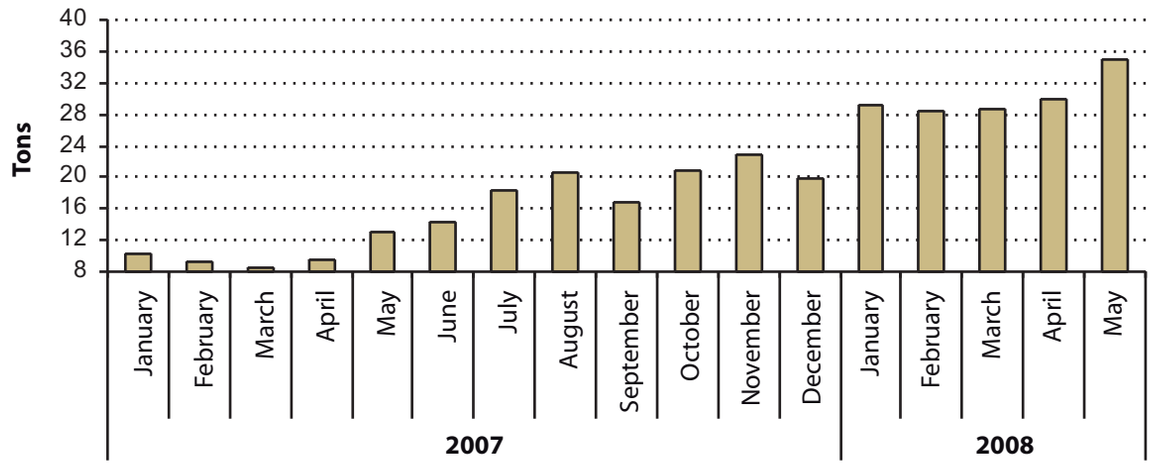


Figure 3. Monthly volume of organic material collected in Santa Cruz in 2007 and 2008.

Photograph: Mandy Trueman

Conclusions

The recycling system on Santa Cruz experienced a notable increase in both recycled and organic materials beginning in the second half of 2007, when greater public participation resulted in the collection and processing of more glass, plastic, paper, and organic materials. The success of this project is due to:

i) Improvements in waste collection;

ii) Continued control of separation of types of waste, and

iii) Educational campaigns focused on recycling practices.

A measure of the efficiency of the entire system is difficult due to the lack of data on the collection and treatment of some types of materials, including scrap iron, rubble, used batteries, weeds, and brush. Based on the weight of the processed material that leaves the Recycling Center, the estimated efficiency of separation and recycling of waste in Santa Cruz ranges from 30-40%. This suggests that the recycling program successfully removes from the environment of Santa Cruz approximately 50% of the waste produced.

General trends in scientific research in Galapagos

Tatiana Santander[1], Washington Tapia[2], José A. González[1], Carlos Montes[1] & Eddy Araujo[2]

1 Universidad Autónoma de Madrid
2 Galapagos National Park

Since the creation of the Galapagos National Park (GNP), the solid link between applied research and management has been one of its greatest strengths, providing a foundation for the development of a system of adaptive management that has achieved notable conservation successes for the protected areas of the archipelago. However, various recent analyses have recognized the urgency of identifying new research needs and priorities to provide decision-makers with the scientific information necessary to better confront future challenges.

The Management Plan of the GNP clearly outlines the necessity of establishing an interdisciplinary research agenda, one that is open and flexible, will provide the knowledge needed for the management of the complex socio-economic of Galapagos, and will promote a scientific culture that facilitates the fluid participation and collaboration of all stakeholders.

This analysis of general trends in Galapagos research was completed in an attempt to establish a baseline for the current status of knowledge and to identify biases and possible information gaps. An initial database was constructed consisting of 10 081 references recorded between 1535 and 2007. This was then filtered to eliminate grey literature, studies of a regional character, and duplicated references published in various languages. The resulting database was reduced to 4884 references, which were then analyzed, beginning with a categorization of each reference on the basis of 82 key words. Some analyses were repeated for a sub sample consisting of only 1392 references, which included only cited publications in journals of "high impact" (defined as those included in Journal Citation Reports® - JCR).

Evolution of the scientific effort

This analysis of scientific research reveals a growing cumulative effort and reflects the importance of key historical events that caused a directional change in research carried out in the archipelago, such as the California Academy of Sciences expedition, the creation of the Charles Darwin Foundation (CDF), and the enactment of the Special Law for Galapagos, among others (Figure 1).

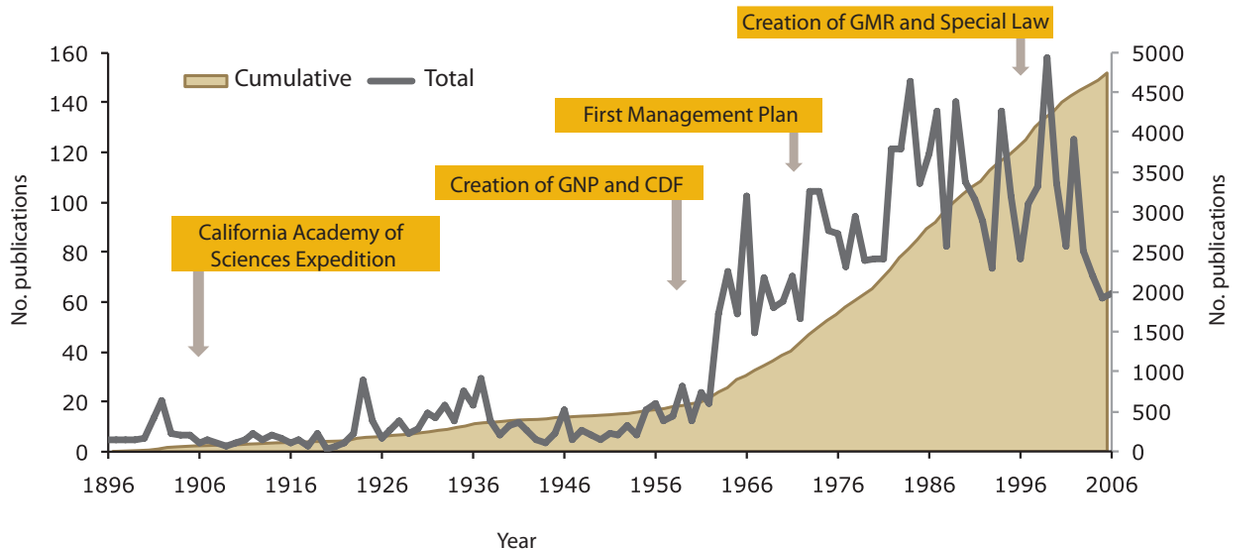
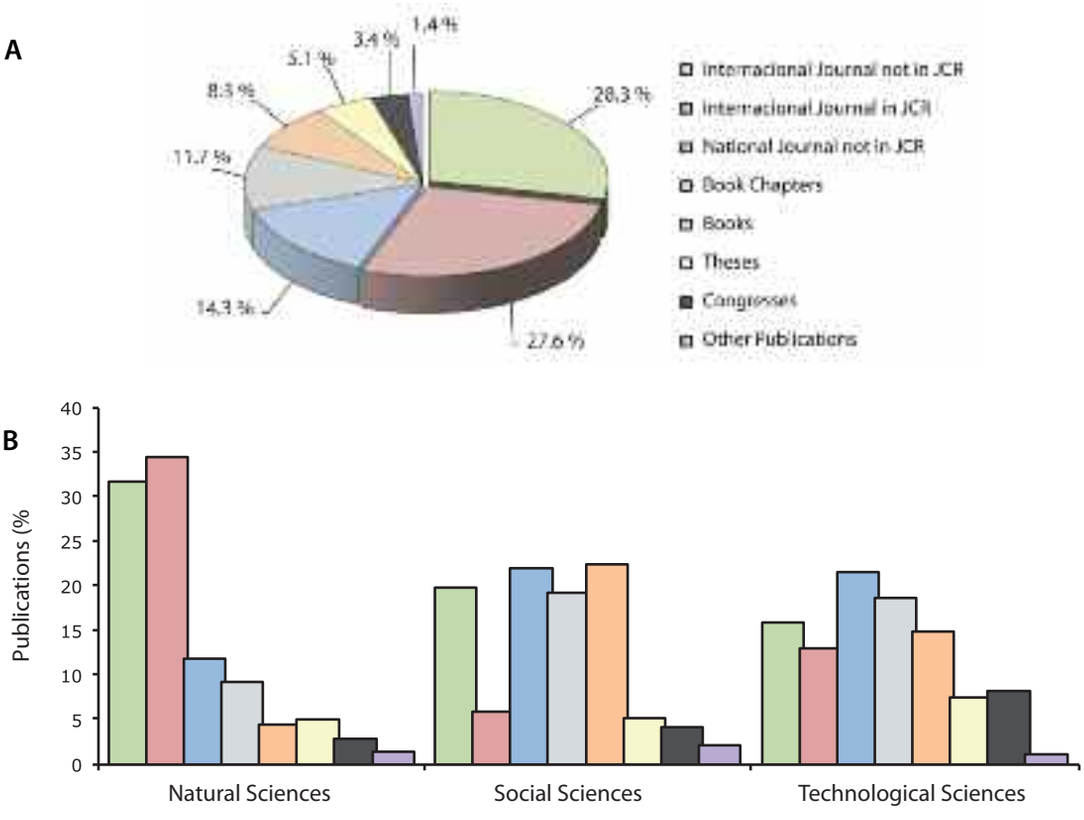


Figure 1. The evolution of scientific effort measured as the annual and cumulative number of publications, with key events that impacted the research carried out in Galapagos indicated by date. GMR = Galapagos Marine Reserve.

General characteristics of the publications

A majority of articles (55% of those registered) was published in international journals. However, the percentage varies greatly when major scientific disciplines are analyzed separately (Figure 2). In natural sciences, articles published in international journals of high impact continue to predominate. In the case of the social sciences and technological science, books, book chapters, and national journals constitute the primary mediums of publication. In terms of language, English clearly is the dominant language of publication (71.9%), while Spanish is second (20.3%).

Figure 2. Distribution by type of publication (A: the full database; B: by major areas of knowledge).



Another notable aspect is the low level of interdisciplinary research in Galapagos. Only 8% of the references include some type of collaboration between different academic disciplines. This percentage declines to 3.3% when only the research published in scientific journals of impact are included. At the same time, there is a clear predominance of basic over applied research and evaluative or follow-up studies (Figure 3). It must be noted however that a large body of applied research used for management can be found in the grey literature but these publications remained outside of the focus of this analysis.

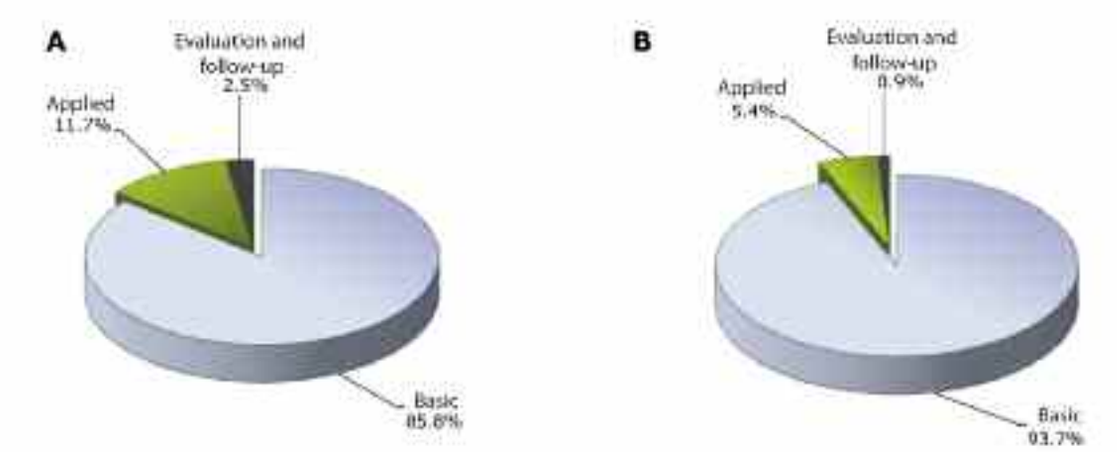


Figure 3. Type of research carried out in Galapagos (A: the full database; B = including only those articles published in journals of the JCR).

Trends by scientific discipline

The analysis by scientific discipline reveals a clear predominance of natural sciences (74.4%), which is even more evident when analyzing only those articles published in journals of impact, in which case the social sciences and technological sciences decline to a marginal level (Figure 4).

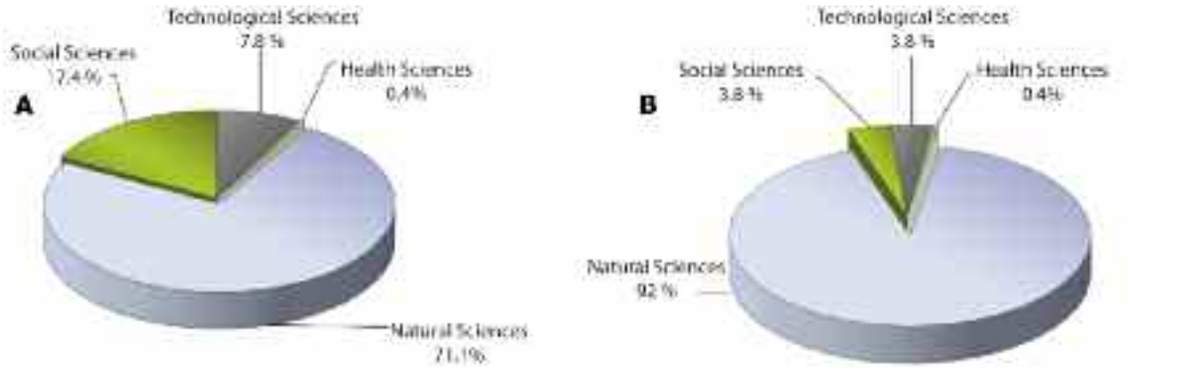


Figure 4. Percent of publications in the four main scientific disciplines (A: full database; B: only those articles published in journals of the JCR).

The evolution over time in the number of references published by scientific discipline highlights interesting trends (Figure 5). For example, there was an exponential growth in scientific research in Galapagos starting with the creation of the GNP and the CDF, in comparison with the preceding half century. However, this growing trend ended during the last two decades. The contrary effect can be seen in the social sciences and technology, both of which experienced a significant increase during recent years.

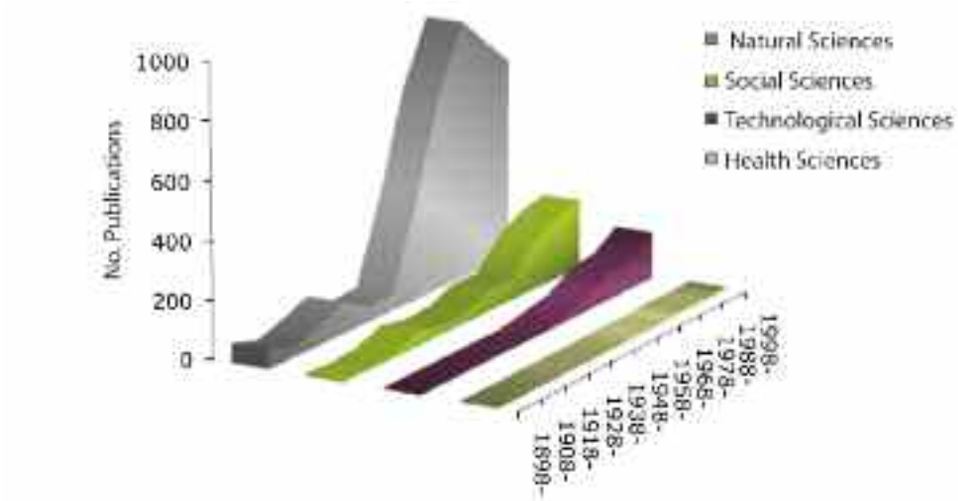


Figure 5. Historical evolution in the number of publications in the four scientific disciplines analyzed.

Research objectives

Analyzing the publications according to the focus of the research demonstrates some of the biases characteristic of research in Galapagos. In natural sciences, there is a clear dominance of research focused on taxonomy and biogeography, evolutionary ecology, and conservation biology (Figure 6). In social sciences, studies related to geography and history predominate. However, there is a notable peak that reflects studies of fisheries in journals of impact.

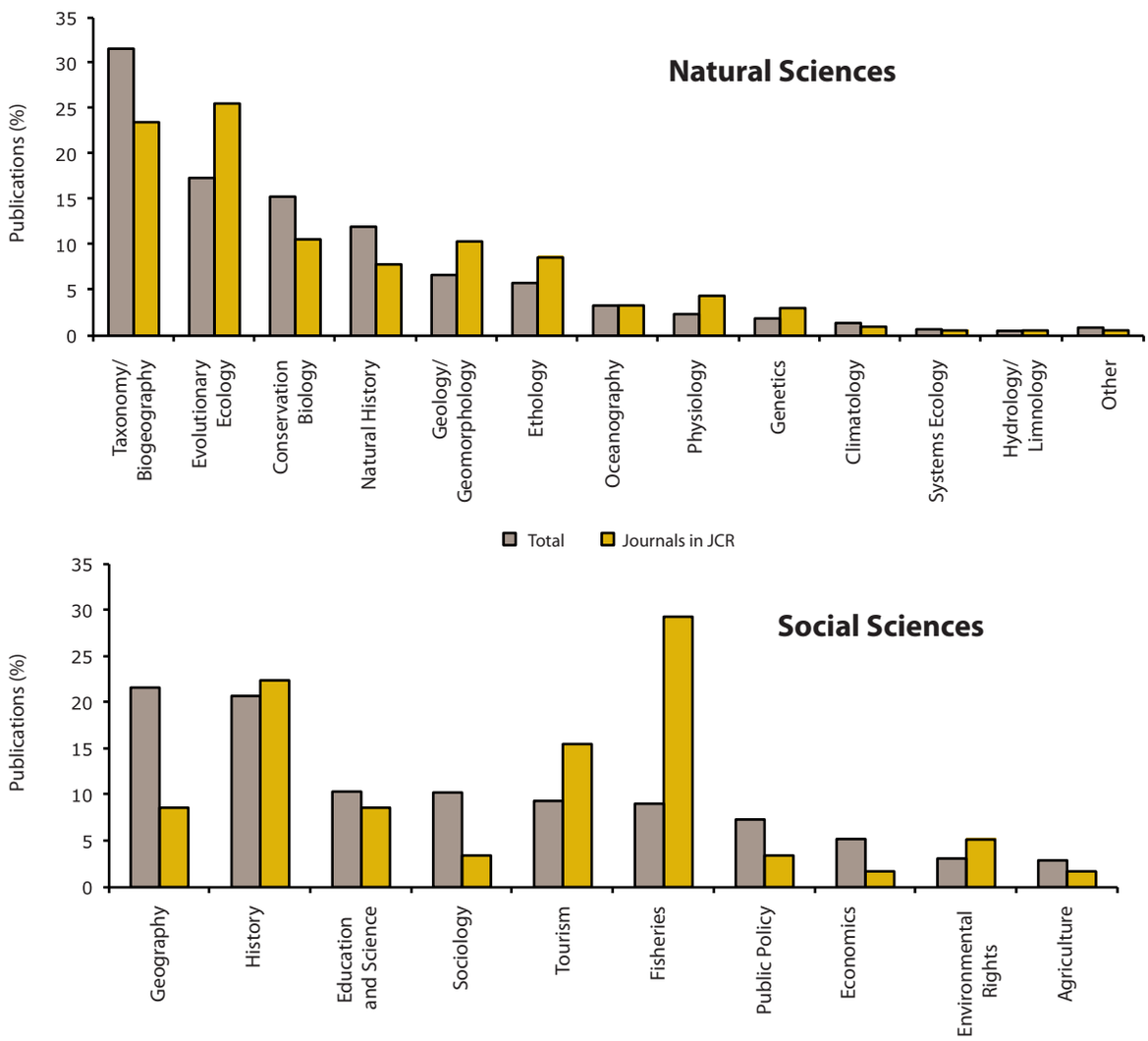


Figure 6. Percent of publications by focus of research in the two disciplines that contain the majority of publications.

Research effort by taxonomic groups

In natural sciences, the distribution of publications according to taxonomic group shows a clear bias toward higher organisms (Figure 7). Vertebrate studies account for 54.8% of all publications, while other taxonomic groups, such as fungi or microorganisms, received much less attention.

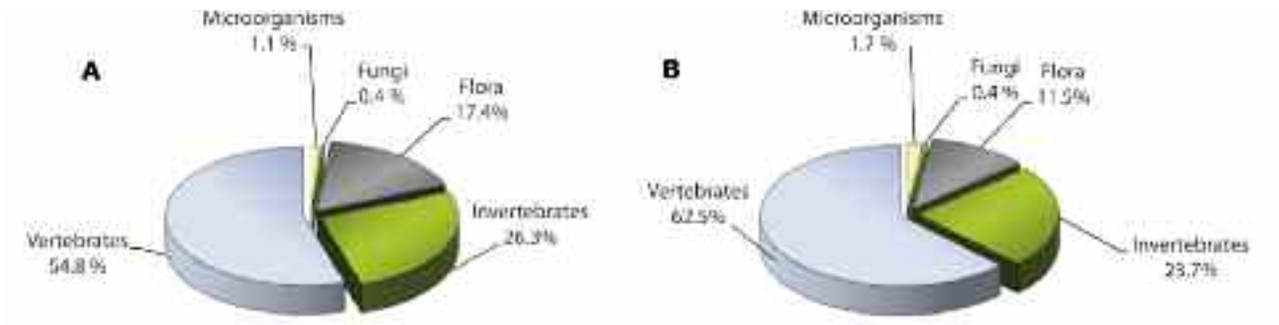


Figure 7. Percent of publications by taxonomic group (A: complete database; B: articles published in journals of the JCR).

The number of references by taxon also reveals a notable bias toward birds and reptiles, which becomes especially evident when the analysis includes only those articles published in journals of impact. In the case of publications on introduced species, there is a clear predominance of studies focused on mammals (Figure 8).

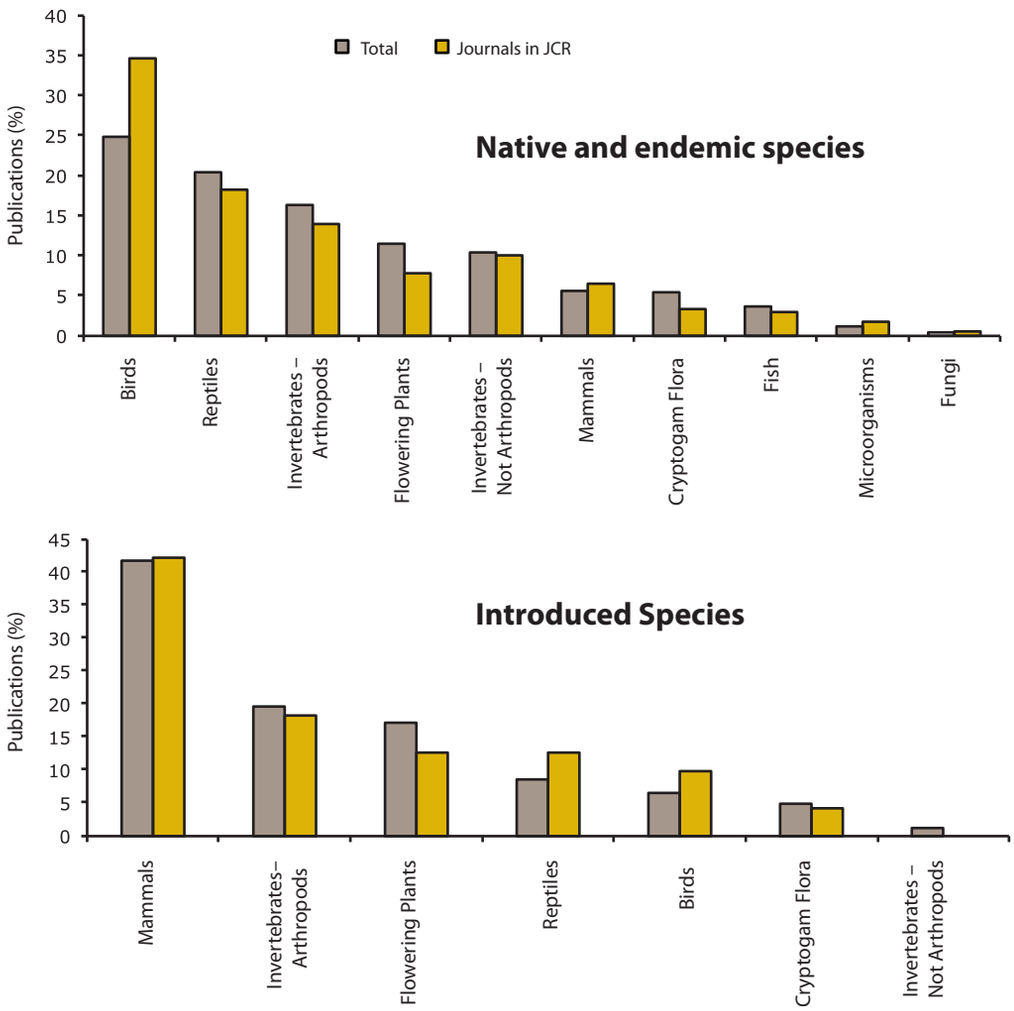


Figure 8. Percent of publications by major taxonomic groups.

Photograph: Frank Bungartz

Conclusions

In spite of the solid historical relationship between research and management and the fact that Galapagos is probably one of the most studied places on the planet, it is evident that the research to date has been biased toward specific aspects of the biophysical sciences and toward specific taxonomic groups, with a scarcity of applied or interdisciplinary research that span the connections between nature, society, and the economy. This biocentric focus, characteristic of the science in Galapagos, has provided an exhaustive and very valuable body of knowledge on certain subjects (e.g., biology and ecology of emblematic species and management of introduced species), while other social or ecological processes essential to sustainability remain practically unexplored (e.g., water cycles, nutrient cycles, functional diversity, etc.).

As has occurred in many other world renowned protected areas around the world, these results are probably a consequence of historical patterns where research begins with the larger species that are obviously threatened and is not focused on the overall ecosystem. Many times a research policy founded on a shared vision of all stakeholders is lacking. The new Management Plan of the GNP tries to resolve this deficiency with its Program of Interdisciplinary Research and Technological Innovation. This cross-cutting program creates a foundation for a new model of research directed at achieving sustainability in the archipelago. With this, the GNP is endeavoring to stimulate and coordinate a science policy that will help to efficiently respond to the challenges created by the changes in Galapagos during the last decade, changes that make greater diversity of knowledge both urgent and critical for more effective decision-making.

The development of this new model for research is considered a priority, in line with the Management Plan of the GNP and especially needed in the moment of crisis in which Galapagos finds itself. Research priorities should be established based on objective criteria about the real needs for knowledge. This change signifies moving from a model of "research in Galapagos" to a new paradigm of "research for Galapagos."

Biodiversity and Biophysical Resources

Advances in the conservation of threatened plant species of Galapagos

Rachel Atkinson[1], Patricia Jaramillo[1], Walter Simbaña[1], Anne Guezou[1] & Vanesa Coronel[2]

1 Charles Darwin Foundation
2 Agricultural University of Sweden

Introduction

Oceanic island floras show high levels of endemism but are usually severely threatened by introduced species and habitat alteration. Due to the limited land area, population sizes tend to be small naturally and are thus even more susceptible to extinction. The flora of Galapagos is no exception. A recent analysis by Tye (2007) suggests that 60% of 168 endemic plant species are threatened according to IUCN Red List criteria. These species have become increasingly rare due to the impact of introduced herbivores and development. Management actions have been carried out in an attempt to reverse population declines for many of these species, with action ranging from island-wide eradication programs to localized fencing to prevent damage from humans and herbivores. Sometimes, however, these actions have not led to population recovery and further studies are required to understand what other factors may be limiting the species.

This paper reports on the advances made in the conservation of 18 of the rarest endemic plants in Galapagos over the last ten years. To provide specific examples that illustrate the complexity of plant conservation, the actions and research carried out for individual species have been grouped into three sections: (i) preventing herbivory; (ii) reducing the impact of development; and (iii) understanding life histories.

1. Preventing herbivory

Introduced herbivores are known to be one of the greatest threats to plant biodiversity. Two strategies have been adopted in Galapagos to remove the impact: island-wide eradication of introduced herbivores and localized protection through fencing.

a) Island-wide eradications

After many years of herbivore control, Santiago and Floreana have joined an increasingly long list of islands free of goats, donkeys, and pigs (Lavoie et al., 2007). Three threatened plant taxa on Santiago and six on Floreana have been studied during this period to determine the effect of herbivore eradication. Some species have shown a dramatic increase in their abundance following herbivore eradication (Table 1).

For seven of the taxa, the number of known populations has increased. Six of the species show a marked increase in total population size, even though not all populations were surveyed in 2007. The only species that does not show a population increase is *Alternanthera nesiotes*, but this may be a consequence of limited sampling. All species had juveniles present in 2007, evidence of active population growth.

b) Fencing individual populations

To date it has not been possible to eradicate introduced herbivores from all islands and fences have been used to provide localized protection. Here we report on ten fencing projects that were undertaken to protect populations of five threatened species from herbivory on the inhabited islands of Isabela (Volcán Sierra Negra), Santa Cruz, and San Cristóbal. Fences range in size from 25 m^2 to several hectares, protecting one individual to entire local populations (Table 2).

Unfortunately, it has been difficult to quantify the net conservation effect of the fences on the survival of the threatened species. While fences protect plants from herbivory, they can sometimes lead to other problems, such as allowing excessive growth of competitive plants.

2. Reducing the impact of development

The increasing human population in Galapagos is leading to encroachment into the natural ecosystems. Habitat alteration over even very small areas can impact heavily on island floras due to the presence of restricted-range endemics. However, it can also have surprising results. Below are two contrasting examples from Santa Cruz:

a) *Scalesia affinis*

Scalesia affinis (a beautiful small tree with tobacco-shaped leaves and white, daisy-like flowers) has been reduced to 71 plants on Santa Cruz (Jaramillo,unpublished 2005). Most of these individuals are located at the edge of Puerto Ayora in a zone used in recent decades for rock extraction and rubbish dumping but now demarcated for a new housing development. Other isolated individuals occur along the road near to a recently built office complex and several were destroyed during construction of the village bus terminal.

To prevent further destruction, two small fences were built in 2005 to protect three individuals located close to the main road. In 2007 a larger fence was built to protect the remaining unfenced plants (Table 2). The fences have successfully protected the individuals but the long-term survival of the last population on Santa Cruz is uncertain given the demand to develop the surrounding land.

b) *Acalypha wigginsii*

Acalypha wigginsii (an unremarkable straggling woody herb that grows up to 1 m tall) is restricted to the fern-sedge zone on the ridge of Cerro Crocker on Santa Cruz. In 2000 a new telecommunications antennae was built on the top of the hill, destroying the largest known population of this species and reducing the total population to 100 plants. As a result the species was classified as Critically Endangered (Tye, b;2002).

In response to concern over its future, the species has been monitored since 2001. Unexpectedly, the population has increased over this period (Figure 1). Although the vegetation on the ridge has become invaded by introduced plant

species, periodic weeding around the antennae and access trails appears to help *A. wigginsii*, as it tends to colonize open ground. This finding has led to new management recommendations for the long-term survival of this species.

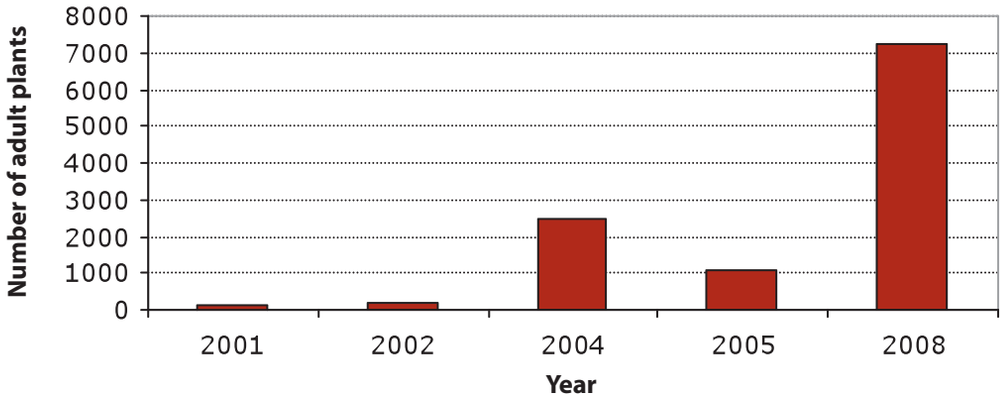


Figure 1. Population size of *Acalypha wigginsii* since the construction of the antennae on Cerro Crocker in 2001.

3. Understanding life histories

Many threatened species have not responded as expected to the management techniques discussed above. In these cases, more detailed studies will help to determine what is limiting population recovery. We present three examples to show the range of problems that can affect species: (i) a naturally low viable seed production in *Scalesia affinis*; (ii) the lack of suitable climatic conditions for germination of *Lecocarpus lecocarpoides*; and (iii) the complexities of plant-herbivore interactions in the restoration of *Opuntia megasperma var orientalis* on Española.

a) *Scalesia affinis*

Unlike most Galapagos endemics, *S. affinis* is known to be partially self-incompatible (McMullen, 1987; Nielsen et al., 2007) and the wild population of this species in Santa Cruz shows very little natural regeneration suggesting there is little outcrossing occurring. Cross-pollination experiments were carried out throughout 2007 to determine if viable seed set could be increased. By the end of the year, 60 young plants had been produced in the nursery from 860 viable embryos, indicating severe reproductive difficulties. These plants have been used to found a new population, although the long-term success of this population will need to be monitored.

b) *Lecocarpus lecocarpoides*

L. lecocarpoides (a pretty shrub with yellow daisy flowers and serrated light green leaves), listed as Endangered (Tye, 2007), is endemic to Española and the four surrounding islets of Oeste, Osborn, Gardner, and Tortuga. All populations fluctuate widely in size, and although relatively common on the islets (a total of 1000 plants being recorded in 2007), only a single individual was recorded at Punta Manzanillo in 2007, suggesting the need for urgent action to avoid local population extinction. Seedbank sampling to a depth of 5 cm in a 2 m^2 plot around the remaining plant resulted in 424 seeds. Results from viability testing of the other populations indicate that about 80% of the seeds are viable. If the hard outer seed coat is broken, the seeds germinate within two days, growing to maturity in three months. It would thus appear that this species is very dependent on specific climatic conditions for population recruitment, conditions that may occur infrequently in Galapagos. Information such as this is essential to understand better the dynamics of the population and determine pragmatic conservation management plans.

Photograph: Mandy Trueman

c) *Opuntia megasperma* var. *orientalis*

O. megasperma var *orientalis* (a fat tree cactus with a long straight trunk topped with a crown of cactus pads) is found on San Cristóbal and Española and is IUCN red listed as Endangered (Tye, 2007). The population on Española was severely damaged by goats. However, goat eradication in 1978 has not yet resulted in the recovery of this keystone species, even after 30 years.

It seems unlikely that the reproductive system is limiting the recovery of Opuntia as fruits are regularly produced, seed viability is high (an average of 74% across the three main populations; Coronel, 2000), and seedlings are easy to propagate *ex-situ*.

Opuntia is a favorite food of tortoises and an intensive captive breeding program, initiated in the 1970s, has released over 1 000 tortoises back onto the island (Marquez *et al.*, 2003). To test whether this artificially rapid "recovery" of the natural herbivores has been too fast to allow for cactus regeneration, a caging experiment was begun in 2007. Preliminary results show that cages do help increase survivorship of young plants and pads; all the pads outside of the cages were eaten, suggesting that the interaction between tortoises and Opuntia may be an important component in the recovery of this species (Coronel, 2002).

Conclusion

The information presented above on 18 of the rarest plant species in Galapagos shows the complexity and diversity of problems associated with their conservation. One constraint to understanding the response of management actions by individual plant species has been the lack of consistent monitoring protocols and robust experimental design. Part of the reason for this is the degree of crisis management involved in the conservation of species on the brink of extinction. However, as many of the more detailed case studies show, species response to simple management measures is idiosyncratic, and species need to be considered individually within their natural ecosystem to determine whether management actions have aided their recovery.

Evaluating the effectiveness of a decade of conservation measures is an important exercise to both reveal new trends and optimize future action so that the threatened plants of Galapagos can persist in the long term.

Table 1. Changes in the population size and number of nine threatened plant species with herbivore eradication on Floreana and Santiago.

Taxon (IUCN Theat category*)	Island	Population information prior to herbivore eradication				Population information post herbivore eradication			
		Year	No. adults	Seedlings to adult ratio	No. populations	Year	No. adults	Seedlings to adult ratio	No. populations
Scalesia affinis (VU)	Floreana	2000[3]	100	not known	2	2007	299	0.3/1	3
Alternanthera nesiotes (EN)	Floreana	1998[1]	4500	0.6/1	5	2007	>715 [a]	0.1/1	10
Lecocarpus pinnatifidus (CR)	Floreana	2004[3]	1000s	not known	6	2007	>6000 [b]	1.9/1	13
Lippia salicifolia (CR)	Floreana	1998[1]	2600	0.5/1	10	2007	1591	0.8/1	10
Psychotria angustata (CR)	Floreana	1998[1]	250	0.1/1	3	2007	264	4.5/1	4
Linum cratericota (CR)	Floreana	1998[1]	13	not known	1	2007	300	0.7/1	1
Scalesia atractyloides var. *atractyloides* (EN)	Santiago	1998[2]	2	not known	1	2007	>21 [c]	0.5/1	4
Galvezia leucantha subsp. *porphyrantha* (EN)	Santiago	2000[2]	130	not known	3	2007	>220 [d]	0.4/1	6
Scalesia atractyloides var. *darwinii* (EN)	Santiago	1995[2]	5	not known	1	2007	>1404 [b]	1.6/1	12

*CR: Critically Endangered, EN: Endangered, VU: Vulnerable. Taken from Tye (2007)

[1] Mauchamp *et al.* (1998), [2] Tye & Jaeger (2000), [3] CDF unpublished data

[a] 3 populations surveyed, [b] 11 populations surveyed, [c] 1 population surveyed, [d] 5 populations surveyed

Table 2. Details of the fences built to protect six threatened plants species from herbivory and human activities.

Taxon (IUCN Theat category*)	Island	Date of fencing	Location	Area fenced (m^2)	Reason for fencing	Number of individuals fenced	% of local population protected	% of total individuals protected	Notes
Scalesia cordata (EN)	Isabela	1993, enlarged in 2000	Bosque de los niños	240	pigs, cattle	20	100	46	The last population within the agricultural zone
		2006	Cerro Colorado (Sierra Negra)	10,000	pigs	77	20		One of 13 populations within the National Park
Calandrinia galapagosa (CR)	San Cristóbal	1993	Cerro Colorado	320	people, goats, donkeys	89	70	57	Donkeys have also been controlled in the area
		2003	Ripioso	10,000	goats, donkeys	380	100		This fence also protects *Lecocarpus leptolobus*
		2005	Bahía Rosa Blanca	100	goats	3	40		
Darwiniothamnus alternifolius (CR)	Isabela	2006	Sierra Negra	625	pigs, cattle	35	5	100	
		2008	Sierra Negra	20,000	people, pigs,cattle, horses	1300	100		80% of the plants within the fence are seedlings
Scalesia affinis (VU)	Santa Cruz	2005	Puerto Ayora	25	people, donkeys	1	1	100	Plant grows in an area under development
		2005	Puerto Ayora	25	people	2	5		Plant grows in an area under development
		2007	Terminal Terrestre	14,400	people	65	80		Plants grow in an area under development
		2008	Carretera Garrapatero	10,000	people, donkeys	3	100		
Lecocarpus darwinii (EN)	San Cristóbal	1993, rebuilt in 2000	Cerro Colorado	320	goats, donkeys	280	80	56	Donkeys have also been controlled in the area
Lecocarpus leptolobus (CR)	San Cristóbal	2003	Ripioso	10,000	goats, donkeys	110	100	77	This fence also protects *Calandrinia galapagosa*

*CR: Critically Endangered, EN: Endangered, VU: Vulnerable. Taken from Tye (2007).

Bird mortality by vehicles

Gustavo Jiménez-Uzcátegui & Franklin Betancourt

Charles Darwin Foundation

Introduction

Highways are an indispensable part of socioeconomic development (Coelho *et al.*, 2005) but they can have negative impacts on natural habitats (Granizo *et al.*, 2002). One impact is habitat fragmentation, which produces a barrier effect, which can divide populations and lead to extinctions of subpopulations (Arroyave *et al.*, 2006), and a border effect, which includes changes in temperature, humidity, radiation, and wind that penetrates the ecosystem up to 50 m from the roadway (Arroyave *et al.*, 2006), resulting in a change in species distribution and abundance. A more direct and visible impact is that vehicles traveling on these highways can kill animals, with the frequency and velocity of vehicles representing the primary factors affecting population size and animal behavior (Taylor & Goldingay, 2004).

Santa Cruz Island is the tourism and economic center of Galapagos. It is an island where transportation plays an important role in day-to-day life and also affects the fauna of the island. Construction of the highway that crosses the island north-south (connecting Puerto Ayora and the Itabaca Canal) began in 1972 (Loza, 1981), was completed in 1974 (Carvajal, 1980), and finally paved in 2000 (Tanner & Perry, 2005). Meanwhile, the number of vehicles in Santa Cruz has increased from 28 in 1980 (Márquez, 2000) to 1276 in 2006 (Villa, 2007).

A total of 177 bird species have been registered in Galapagos (CDF, 2008), including 56 endemic or native species (Jiménez-Uzcátegui *et al.*, 2007). Of this group, 23 are on the Red List (IUCN, 2007) due to their low population numbers (two endemic species have fewer than 150 individuals) and to anthropogenic problems (Wiedenfeld & Jiménez-Uzcátegui, 2008).

In Santa Cruz there are 37 bird species, 20 of which are affected by vehicles according to studies conducted by the Charles Darwin Foundation (CDF; Table 1).

Table 1. Species hit by vehicles recorded by year of study.

Common Name	Scientific Name	1980	2000	2001	2003	2004	2005	2006
Yellow warbler	*Dendroica petechia aureola*	x	x	x	x	x	x	x
Cuckoo	*Coccyzus melacoryphus*		x	x	x	x	x	x
Mockingbird	*Minus parvulus*	x		x	x	x	x	x
Paint-billed crake	*Neocrex erythrops*			x	x	x	x	x
Smooth-billed ani**	*Crotophaga ani*		x	x	x	x	x	x
Cattle egret**	*Bubulcus ibis*		x	x				x
Yellow-crowned night heron	*Nyctanassa violacea pauper*		x	x	x		x	
Barn owl	*Tyto alba punctatissima*		x		x	x	x	
Short-eared owl	*Asio flammeus galapagoensis*		x	x	x			x
Vermilion flycatcher	*Pyrocephalus rubinus*			x				
Galapagos dove	*Zenaida galapagoensis*		x	x			x	x
Large-billed flycatcher	*Myiarchus magnirostris*	x	x	x	x	x	x	x
Woodpecker finch	*Camarhynchus pallida*			x			x	x
Warbler finch	*Certhidea olivacea*			x				
Small tree finch	*Camarhynchus parvulus*		x	x	x	x	x	x
Cactus finch	*Geospiza scandens*			x	x			
Large ground finch	*Geospiza magnirostris*	x	x	x	x	x		x
Medium ground finch	*Geospiza fortis*	x	x	x	x	x	x	x
Small ground finch	*Geospiza fuliginosa*	x	x	x	x	x	x	x
Vegetarian finch	*Platyspiza crassirostris*	x	x		x			
Unidentified finch*					x	x	x	x
Total number of affected species		**7**	**14**	**18**	**15***	**11***	**13***	**14***

* The unidentified finches are not considered a separate species.
** Introduced species.
Sources: Carvajal, 1980; Márquez, 2000; Llerena *et al.*, 2001; Betancourt *et al.* 2004; Jiménez-Uzcátegui & Betancourt, 2005, 2006, 2007.

These studies reveal a significant increase in the average number of birds killed per km surveyed, from 0.43 in 1980 to 0.70 in 2004 (Jiménez-Uzcátegui & Betancourt, 2004). This increase is due to highway improvements, an increase in the number of vehicles, and the velocity of those vehicles. A slight decrease was registered between 2004 and 2006 (not statistically significant), which could possibly be due to increased speed controls (Figure 1).

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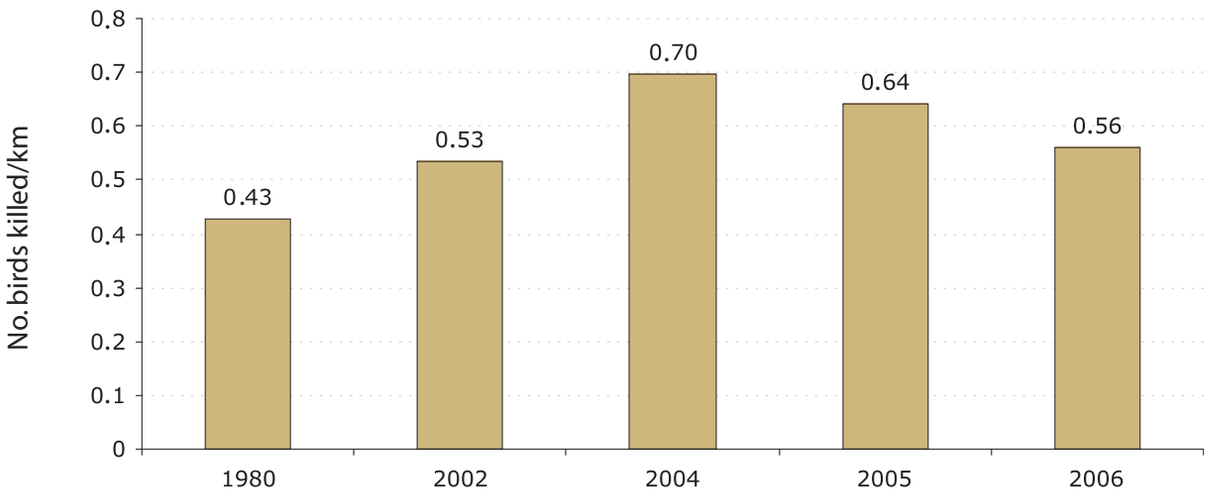

Figure 1. Average number of birds killed on the highway per km surveyed.

In 1980, the small ground finch was the species most affected (Carvajal, 1980). However, between 2004 and 2006, the yellow warbler was the most affected followed by two species of finch (Figure 2).

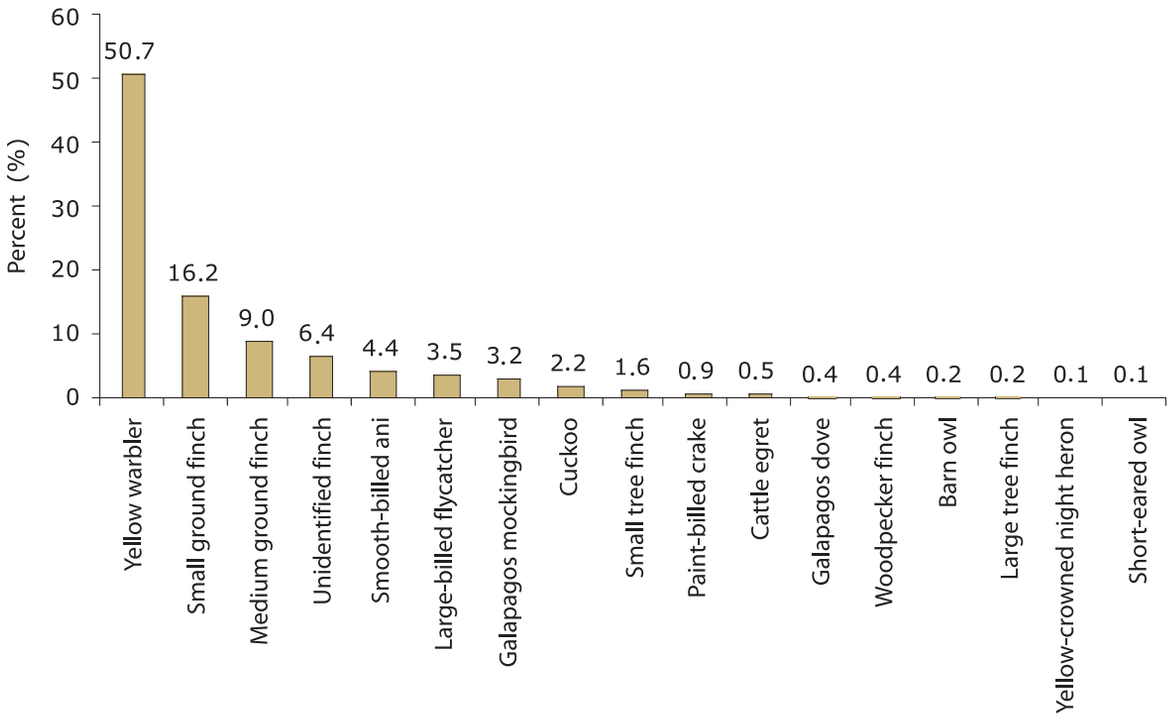

Figure 2. Percentage mortality by species along the Puerto Ayora-Itabaca Canal highway (2004 to 2006).

From 2004 to 2006, a total of 824 dead birds were collected in 33 days of monitoring (one day per month during each year), representing an average of 25 birds per day (the highway was cleaned of dead birds on the day prior to monitoring). The methodology was based on Llerena *et al.*, 2001. Based on these data, it is estimated that from 2004 to 2006, 9000 birds were killed on the highway and that each vehicle on Santa Cruz killed an average of seven birds per year. A greater number of dead birds were found during the hot season (January to June) (Figure 3).

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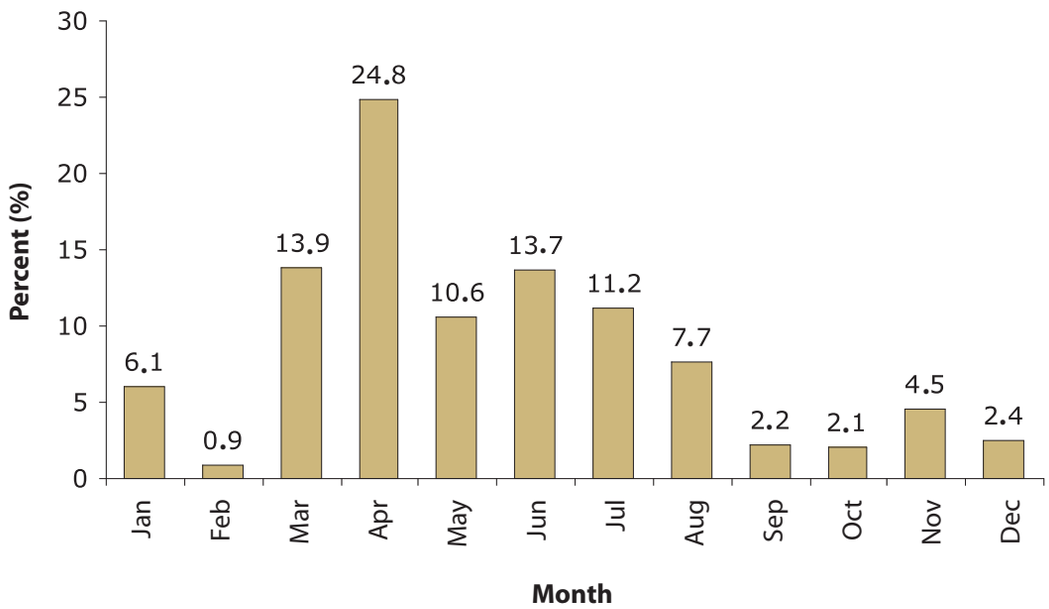

Figure 3. Percentage of dead birds on the Puerto Ayora-Itabaca Canal highway by month (2004 to 2006). Source: Jiménez-Uzcátegui & Betancourt, 2005, 2006, 2007.

On the basis of these findings, the CDF, the Galapagos National Park (GNP), and the Environmental Protection Unit of the National Police have held workshops for local drivers, improved the system for controlling speed of vehicles, constructed speed control devices, etc., to reduce bird mortality. However, the data show that these efforts have not achieved the desired results.

Recommendations

Training

Organize workshops for drivers covering traffic laws and the problems that vehicles cause for the fauna, making passing the course a requirement for obtaining a driver's license.

Maintenance and signage

a. Place traffic signage on the highways: metallic and/or painted signals on the asphalt.

b. Cut the vegetation to a distance of 1 m from the shoulder along the sides of the highway to improve visibility.

Control

a. Improve the regulations for vehicles entering and leaving the archipelago. This regulation is currently under revision.

b. Intensify the control of vehicle speed, especially during the hot season.

c. Apply norms for the use and control of vehicles as established in the Management Plan for the GNP, with respect to roads and transportation within the park zones.

d. Identify public use vehicles with visible numbers on their exterior.

Driving

a. Use the horn when species are observed on the roadway.

b. Respect traffic signals and laws.

Future

a. Install internal speed blocks in vehicles with a limit of 80 km/hour (except for ambulances, fire engines, and police).

b. Implement an integrated and environmentally-friendly system for mass transportation (light rail or vehicular) over the long term, both in Baltra (Itabaca Canal to the airport) and in Santa Cruz (Puerto Ayora to Itabaca Canal).

Conclusion

The principal cause of bird mortality along Galapagos highways is excessive speed of vehicles. Therefore all drivers must be conscious of the importance of obeying all traffic laws. Habitat fragmentation in the ecosystem resulting from the presence of highways has a significant impact on the native fauna populations of Santa Cruz. Currently we do not know the quantitative impact of vehicles on the fauna of the other islands. Therefore, it is recommended that similar studies be carried out in Isabela and San Cristóbal. The anthropogenic stress in the wild populations of native and endemic species is high, which can have a notable effect most especially on the species that are currently found on the Red List.

Dispersal of insect species attracted to ship lights: Conservation implications for Galapagos

Lázaro Roque-Albelo, Edison Lomas Chauca, & Omar Castillo Gaona

Charles Darwin Foundation

Over the past century, the Galapagos Islands have suffered numerous transformations in the composition of their flora and fauna as a result of human colonization and the introduction and establishment of exotic species. The opening of more routes to Galapagos, the increase in the frequency of arrival of ships and planes, and the increase in imported products has compromised the natural isolation of the archipelago and resulted in the islands becoming filled with various introduced plants and animals.

Insects comprise the group of organisms with the highest capacity for arrival and eventual movement among the islands of the archipelago, due to the small size of most species and their dispersal strategies. Causton *et al.* (2006) reported that there are 463 species of introduced insects in Galapagos. Following their initial arrival, 73% of these species have dispersed to other islands within the archipelago and some have caused serious negative impacts (e.g., fire ants and wasps).

Silberglied (1978) was the first to discuss the introduction and dispersal of insect species in Galapagos through their attraction to the lights of ships that arrive from the continent and travel among the islands. This preliminary study, which collected data from only two tourist boats, reported 16 different species of insects attracted by ship lights. It highlighted two key considerations: (i) the introduction and dispersal of exotic species via boats traveling among the islands and (ii) the consequences that such dispersal could have on the biogeography and evolution of Galapagos species. During the more than 25 years since Silberglied's study, the tourist industry has undergone notable growth and development. The number of visitors has increased from 11 765 in 1979 to 161 859 in 2007 (GNPS archives). This increase in the number of visitors has brought with it an increase in the number and size of tourist boats that operate in Galapagos and in the number of visits to the various islands.

The Galapagos Islands are also visited occasionally by international cruise ships such as the M/N Discovery as well as smaller yachts. These vessels, some of which are very large and have many external lights, put in at various international ports prior to their arrival in Galapagos, posing a serious risk of introducing species to the archipelago.

The analysis of different means by which insects and other invertebrates are able to disperse within the archipelago that are dependent upon human activity is very important because it enables us to recommend mitigation measures. In this context, the Charles Darwin Foundation (CDF) has carried out research since 2001 to analyze this phenomenon and recommend mitigation measures. This article discusses the results of studies based on the collection of insects from tourist ships in 2001, 2002, 2007, and 2008, as well as the collection carried out aboard the M/N Discovery in 2007.

Results

The research demonstrates that the transport of insects attracted by onboard lights is a common phenomenon that has received little attention during the development of tourism management plans. The quantity of insects attracted to ship lights of tourist vessels depends upon: (i) environmental factors such as season, wind direction and velocity, the presence or absence of a full moon, etc.; (ii) physical factors such as the distance of the vessel from shore, the type and quantity of lights, etc.; and (iii) biological factors such as species diversity on the island, biological characteristics of each species, etc.

Calculations of the number of insects that can be transported by this medium vary greatly. For example, results of the research in Puerto Ayora in 2001 and 2002 showed that a medium-sized boat with 18 external lights could attract an average of 150 insects in three hours during the dry or garúa season (8.3 insects per light) and 466 insects in the rainy season (25.8 insects per light). When extrapolated to a full year, this results in 102 150 insects per year that could be attracted to the lights of a single boat and dispersed to other islands. If these results are then extrapolated to one of the larger tourist vessels with an average of 65 external lights, the number of insects that could potentially be dispersed by a single boat in a year is 367 543 (Roque-Albelo *et al.*, 2006). These figures can also be extrapolated to the entire fleet. Similar results were obtained in the collections in 2007 (Table 1), when a large number of specimens were collected from ship lights (Lomas, 2008).

Table1. Number of insects attracted to the lights of tourist vessels examined in 2007 in Puerto Ayora.

Name of vessel	Size (m)	Number of lights	Number of insects attracted to the lights
Eclipse	64	46	217
Isabela II	54	60	140
Polaris	72	75	123
Santa Cruz	72	63	153
Xpedition	89	75	139

Of even greater concern is the number of species that could be introduced to the islands through frequent visits by international vessels. One study onboard the M/N Discovery in 2006 detected 653 specimens of terrestrial invertebrates that could have been introduced to the islands if the insect monitoring system of the vessel or the intensive collections by researchers of the CDF, the Galapagos National Park (GNP), and the Ecuadorian Quarantine Inspection Service for Galapagos (SICGAL) had not occurred (Roque-Albelo *et al.*, 2007).

Are the color and type of light important in attracting insects?

Nocturnal insects are extremely sensitive to lights because they have developed special adaptations to them. The majority of insects are attracted to lights with low wave-lengths in the ultraviolet region of the electromagnetic spectrum, which includes both white and black lights. This

attraction is due to the sensitivity of the eyes of the insects to a wave-length of 254-600 nm. This same principal is used in the design of electronic insect collectors that use an ultraviolet light and an electric field that kills the insects that are attracted to the light.

The majority of boats in Galapagos use yellow or white incandescent or fluorescent lights. These lights have a wave-length of 300-700 nm and insects are attracted to some of them. For this reason the use of these types of lights is not recommended for vessels in Galapagos. Alternatives that have not been commonly used are orange-red lights and low-pressure sodium lights. These lights are not visible to insects because they have a wave-length greater than the detection ability of these organisms.

Implications for conservation

The dispersal of species between islands by vessels can have serious impacts on the biodiversity and evolutionary processes of Galapagos, especially considering that many endemic insects of Galapagos are restricted to a single island in the archipelago (Peck, 2001; 2006). Another potential consequence resulting from the unnatural dispersal of insects by boats includes the probable genetic contact between co-specific populations that are geographically isolated, potentially decreasing the separation between species. It is important to conduct additional research on this issue in order to establish the actual impact of this dispersal on the unique organisms of Galapagos.

The dispersal of introduced species deserves special attention. These studies indicate that there are various introduced species that can use the boats to disperse among the islands. Some of these species are highly aggressive and can cause serious losses in agricultural production, and can affect human health and the natural biota of the islands. Some possess biological properties that are typical of rapid invaders of new islands or habitats. The majority of these species were first accidentally introduced to the inhabited islands of the archipelago (Peck *et al.*, 1998; Causton *et al.*, 2006). The risk of their dispersal to and colonization on pristine islands increases if boats visit an altered island the night before. An improved design of itineraries for visiting tourist sites should focus on minimizing the risk of dispersal of species to pristine islands such as Fernandina.

Recommendations

The following measures are recommended to decrease the risk of dispersal of insects by boats:

1. Design itineraries for tourist boats taking into account the number of introduced species that are found on each island. For example, a tourist boat should not visit Fernandina (an island with few introduced species) if on the previous night it was anchored at Santa Cruz or San Cristóbal, where there are many introduced species.

2. Replace the ultraviolet and white lights currently used on many of the boats with yellow or orange-red lights or low pressure sodium lights that are less attractive to insects.

3. Turn off the onboard external lights at least two hours before departure from a port and immediately deploy insect traps. These traps are equipped with ultraviolet light and an electric field to attract and then kill the insects.

4. Carry out research to determine the diversity and abundance of insects that are dispersed during the year and the effectiveness of trapping and improved light systems in order to improve the design of itineraries to the various islands and mitigation measures to ensure a decrease in the dispersal of insects in the islands.

The impact of ecotourism activities on wildlife and sessile benthic species in the Galapagos Marine Reserve

Priscilla Cubero-Pardo[1] & Eddy Araujo Bastidas[2]

1 Charles Darwin Foundation
2 Galapagos National Park

Introduction

Ecotourism, when developed according to management guidelines that permit its sustainability, has been highlighted as a socioeconomic alternative with high potential that can be used as a conservation tool in protected areas (Clarke, 1997; Curry *et al.*, 2001; Sirayaka *et al.*, 2001; World Tourism Organization, 2002; Levett & McNally, 2003; Sundstrom, 2003).

In order for ecotourism to become a conservation tool, potential impacts associated with its development must be evaluated and mitigated. The dependence of ecotourism in Galapagos on unique and attractive species, as well as on well-conserved ecosystems, puts the natural balance under pressure and requires that visitor conduct be managed according to guidelines that minimize the effects of their presence.

Methods

The relation between the behavior of visitors and the reactions of key megafauna species during snorkeling, dinghy rides, and SCUBA diving were analyzed (Table 1), as was the frequency of contact with the substrate and sessile benthic species such as sponges and corals (Table 2).

Table 1. Description of human actions and behavioral reactions of the fauna evaluated during ecotourism activities in the Galapagos Marine Reserve.

Human Actions		Animal Reactions	
Category	**Action**	**Category**	**Reaction**
Persecution	Visitors move directly toward the animal	**Evasion**	Change in direction withdrawing from the visitors o leaving the area
Use of flash	Use of flash to photograph an animal	**Alert**	Interruption in the behavior observed when first encountered followed by the animal directing its attention to the visitors
Abrupt movement	Sudden movement of an extremity or the torso by the visitor nearest to the observed animal	**Approach**	Voluntarily approaches the visitors
Noise	Knocking the tank, use of diving alert signal bells, shouting, laughing, speaking loudly	**None**	No change in behavior or direction of movement is observed
Simple presence	None of the above actions occur, the visitor only observes		

Table 2. Description of categories for frequency of contact with benthos analyzed during marine ecotourism activities in the Galapagos Marine Reserve.

Category	Contact with Benthos*
Constant	Visitor grabs hold for more than 1 minute
Frequent	Number of contacts greater than 9
Moderate	Number of contacts between 3 and 9
Rare	Number of contacts less than 3
None	No contact observed

* The count was reinitiated each time the type of substrate or benthos changed.

Results

Reactions of the animals

Samples were taken on 87 days, between July and September 2006 and March to November 2007, aboard 13 cruises that offered snorkeling and dinghy rides. An additional 125 sampling days were completed during 15 live-aboard tours. Fifteen focal species of megafauna were evaluated with a total of 3361 encounters, with the number of encounters per trip ranging from 40 to 613.

Snorkeling was the activity most associated with evasive reactions by the animals. Observing on land while walking along trails at the visitor sites generated the highest occurrence of alert reactions, while SCUBA diving was, in relative terms, the activity most associated with no reaction from the animals. Dinghy rides were most associated with alert and evasive reactions. At the level of species, the frequency of reactions when encountered ranged from 24 to 65%.

The white-tipped shark, whale shark, marbled ray, stingray, and the green sea turtle were the species that showed the highest occurrence of evasive reaction (Table 3). Birds, eagle rays, and marine iguanas mostly showed alert signals, while Galapagos sharks, sea lions, and bottlenose dolphins were the species with a greater tendency to spontaneously approach the visitors. Only in the case of the stingray was there no statistically significant reaction.

Animals responded to flash photography and direct persecution with evasive reactions, with some completely leaving the area. In response to noise, their normal behavior was interrupted and they paid attention to the tourists. Abrupt movements generated both alert and evasive reactions. When confronted with only the presence of the tourists, without any major actions, the animals either showed no change in their behavior or approached spontaneously (Chi-square CoA 905.357, $p < 0.001$, 12 d.f.). The five species that most showed evasive reaction were those that were pursued with greatest frequency and viewed most closely by tourists. The

whale shark was pursued in 73% of the encounters.

When a group of tourists remained quiet in front of an animal or a focal group, there was generally no reaction. When tourists moved about during the period of observation, the frequency of evasive reactions increased significantly. At the same time, when tourists were quietly present, there was a significant increase in spontaneous approaches (Pearson's Chi-square 156.507, $p < 0.001$, 3 d.f.).

Preliminary results indicate that the occurrence of alert and evasive reactions in whale sharks is related to the number of divers present (Log Likelihood Chi-square 31.265, $p = 0.001$, 11 d.f.). The number of encounters tends to increase with the number of divers and the number of alert and evasive reactions by whale sharks increases with the number of encounters (Figure 1).

Table 3. Most frequent reactions to marine ecotourism activities in 15 focal species during the periods July to September 2006 and March to November 2007.

Group	Species	No. of Encounters	Encounters with Reaction (%)	Most common Reaction	Significance
BIRDS	Albatross	52	44	Alert (37%)	Chi-square 41.231, p < 0.001, 3 d.f.
	Cormorant	90	57	Alert (41%)	Chi-square 45.022, p < 0.001, 3 d.f.
	Blue-footed booby	205	49	Alert (40%)	Chi-square 149.556, p < 0.013, 3 d.f.
	Penguin	187	64	Alert (43%)	Chi-square78.647, p < 0.001, 3 d.f.
SHARKS	Hammerhead shark	613	24	No dominant reaction	Chi-square 852.012, p < 0.001, 3 d.f.
	White-tipped shark	88	48	Evasion (32%)	Chi-square 9.667, p = 0.022, 3 d.f.
	Galapagos shark	245	47	Approach (27%)	Chi-square 122.984, p < 0.001, 3 d.f.
	Whale shark	190	43	Evasion (32%)	Chi-square 62.663, p < 0.001, 2 d.f.
RAYS	Eagle ray	130	42	Alert (19%)	Chi-square 77.630, p < 0.001, 3 d.f.
	Marbled ray	69	54	Evasion (38%)	Chi-square 10.174, p = 0.006, 2 d.f.
	Stingray	40	65	Evasion (43%)	Chi-square 2.450, p = 0.294, 2 d.f.
REPTILES	Green sea turtle	551	44	Evasion (31%)	Chi-square 371.577, p < 0.001, 3 d.f.
	Marine iguana	281	50	Alert (32%)	Chi-square 44.420, p < 0.001, 2 d.f.
MAMMALS	Sea lion	544	61	Alert (33%), Approach (24%)	Chi-square 154.495, p < 0.001, 3 d.f.
	Dolphin	59	38	Approach (29%)	Chi-square 50.714, p < 0.001, 3 d.f.

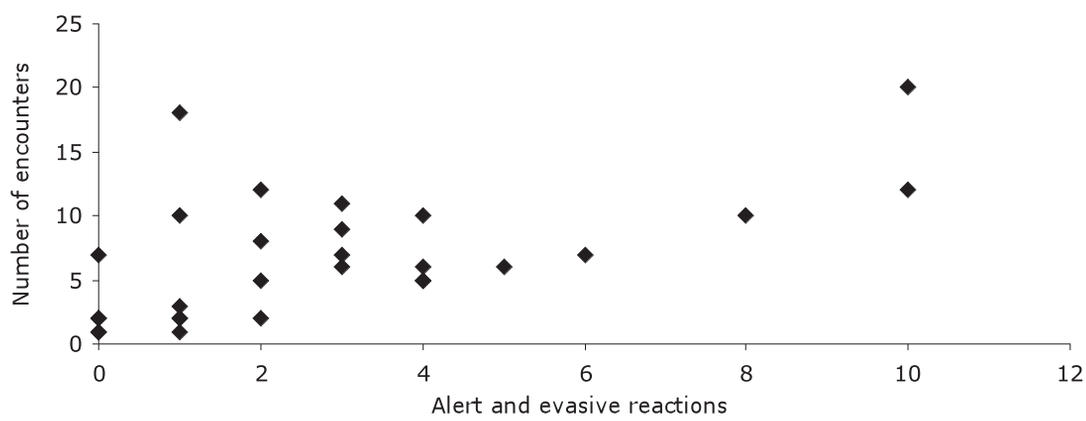

Figure 1. Relation between the number of encounters by divers and the occurrence of alert and evasive reactions by whale sharks during SCUBA dives at Darwin Arch, Galapagos Marine Reserve, July to November 2007.

Effects on the benthos

Eleven snorkeling and 11 dive sites were visited, with a total of 199 and 1007 observations, respectively. At snorkeling sites, the frequency of contact with the substrate varied (Likelihood Chi-square 33.044, p = 0.321, 30 d.f.), with the absence of any contact most frequent. At six sites, 28 to 45% of observations included contact (Figure 2).

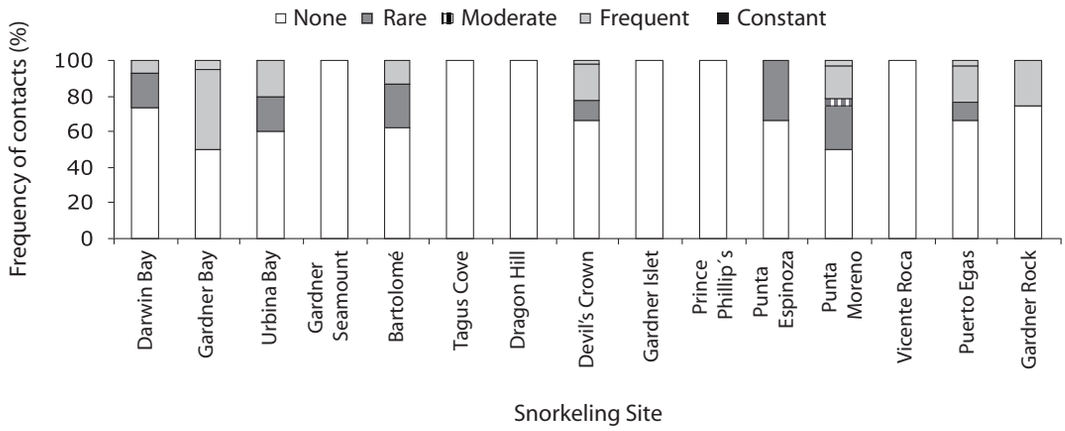

Figure 2. Frequency of contact with the benthos at monitored snorkeling sites in the Galapagos Marine Reserve, July to September 2006 and March to November 2007.

Although the average depth at the 11 sites was significantly different, with a range of less than 0.5 m to 15 m (ANOVA F = 9.960, n = 108, p < 0.001, 10 and 97 d.f.), in general, the depths are such that the visitors cannot touch the substrate. However, with the exception of Gardner Islet and Punta Vicente Roca, all of the sites have shallow areas where it is more likely that visitors will make contact with the substrate.

In the case of SCUBA activities, the frequency of contacts with the substrate and sessile benthos also varied among sites. Darwin Arch and Shark Bay were the sites with the highest frequency of contact (Pearson Chi-square 239.381, p < 0.001, 36 d.f.) (Figure 3). When the current was more intense, the frequency of contact was greater (Chi-square CoA 91.404, p < 0.001, 12 d.f.).

The type of substrate and sessile benthos subject to contact varied according to the site. At Darwin Arch, El Derrumbe, La Punta, and Shark Bay, most contacts were with barnacles and corals; in Banana Islet with sponges, barnacles, and anemones, and in Cousins with black coral. At Mosquera Islet and North Seymour the predominant contact was with rock, while at North Seymour there was also a high occurrence of contact with sand (Chi-square CoA 82.911, p = 0.000, 24 d.f.).

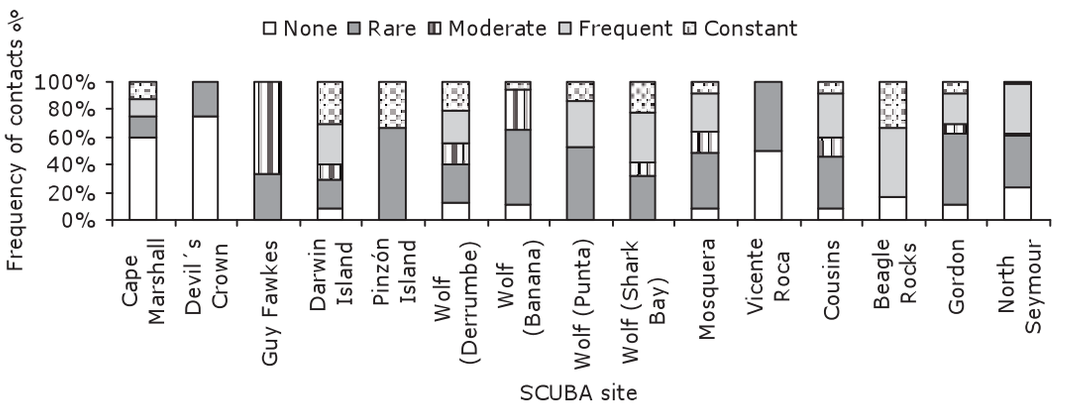

Figure 3. Frequency of contacts with the benthos in monitored SCUBA dive sites in the Galapagos Marine Reserve, July to September 2006 and March to November 2007.

Conclusions

The results of this study reveal clear associations between specific visitor conduct and concrete reactions of the animals. We recommend that special attention be paid to visitor behavior when near white-tipped sharks, whale sharks, marbled rays, stingrays, and green sea turtles, as these are the species that are most pursued and most show evasive behavior.

Snorkeling activities showed a low level of contact with the benthos at the sites monitored. On the other hand, during SCUBA diving, a high level of contact with the benthos was observed, especially at Darwin Arch, El Derrumbe, Shark Bay, and Cousins. Actions taken to improve the conduct of divers could result in a decrease in these occurrences, especially in zones with fragile benthos.

The relationship between the occurrence of alert and evasive reactions by whale sharks and the quantity of divers present and the number of encounters suggest that, apart from only managing visitor conduct, it may be necessary to limit the number of divers interacting at the same time with a specific shark. Since it is likely that some divers may not be willing to remain away from the whale shark while others approach, it may be best to limit the number of divers in the water at any given time.

We recommend that annual monitoring similar to the study presented here continue. It is also important to analyze population dynamics of the megafauna species targeted in this report and to study the percent cover by benthos at the sites with the highest number of contacts.

Toward an ecosystem-based approach to fisheries: a risk analysis

César Peñaherrera & Alex Hearn

Charles Darwin Foundation

Fisheries management in the Galapagos Marine Reserve (GMR) has traditionally focused on the establishment of regulations for specific species, such as the sea cucumber and lobster. However, the white fish fishery targets nine species (Peñaherrera, 2007), with an additional 87 associated or incidental species (Murillo *et al.*, 2003). In fact, the white fish fishery encompasses three very separate sub-fisheries: (i) deep sea fishing, using SCUBA and hand lines with multiple hooks; (ii) fishing with trammel nets, and (iii) trawling for minor pelagic fishes (Peñaherrera, 2007). Due to the variety of techniques used, the intrinsic differences among the species, and lack of sufficient biological knowledge, it is not practical to have regulations for every single species.

The new Management Plan for the Galapagos National Park (GNP, 2005) presents an ecosystem approach that attempts to maintain the functionality of the insular and marine ecosystems through rational use of the resources. This focus also recognizes that human actions involving a single species may have direct and indirect consequences for other species within the ecosystem. For this reason, the Charles Darwin Foundation (CDF) is applying a new methodology, called "Ecological Risk Assessment for the Effects of Fishing" (ERAEF) to analyze the white fish fishery. This methodology was designed in Australia where it has been applied to various industrial and artisanal fisheries (Griffiths *et al.*, 2006; Hobday *et al.*, 2006; Smith *et al.*, 2007). Given the GNP's strong interest in ecosystem-based management, this is an important tool that supports the Park's management objectives.

The purpose of this article is to demonstrate the applicability of the ERAEF as a tool to evaluate and manage Galapagos fisheries and demonstrate its usefulness for future analyses within the GMR.

What is ERAEF?

The ERAEF is a multi-tiered analytical tool involving a preliminary literature review followed by three levels of analysis, with each level examining the previous one in greater detail (Hobday *et al.*, 2006) (Figure 1). The literature

review (Preliminary Level) identifies all of the possible activities and impacts associated with a particular fishery, such as engine emissions, fishing activities, onboard processing, and navigation, among others. If an activity or impact occurs in the fishery that is being analyzed, it is studied further in Level One; if not, it is eliminated from the analysis.

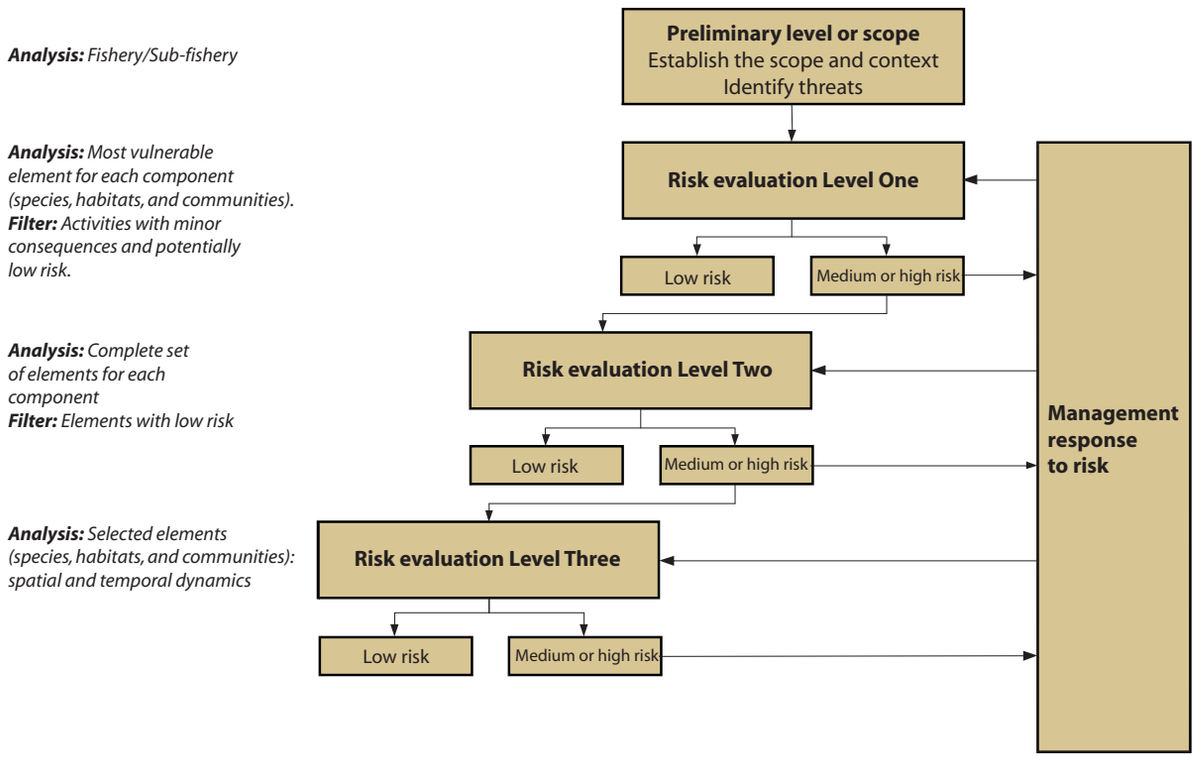

Figure 1. Organizational chart of the ERAEF evaluation system. Modified from Hobday *et al.* (2006).

Level One involves a qualitative analysis of the intensity of each activity and its impact on five ecosystem components: 1) target species; 2) associated species that accompany the target species or bycatch (those not kept by the fisherman); 3) protected, threatened, or endangered species (PTE); 4) habitats, and 5) communities. The results of Level One show the level of risk using a scale of "low-medium-high", with risk level assigned by the evaluators based on the consequences that an activity generates for each component of the ecosystem. If the level of risk of an activity on a specific component is low, no management measures are required. If the risk is medium or high, it requires management measures to reduce possible consequences or it is evaluated at the next level.

Level Two analyzes the risk to each species (target, associated, PTE) based on its biological productivity and its susceptibility to the fishery. Productivity is measured using available information on maximum age and size, age and size at sexual maturity, number of eggs, reproductive strategy, and its nutritional relationship with prey and predators (trophic level). Susceptibility categorizes the risk according to area and depth of the fishing activity in relation to the distributional depth of each species, the selectivity of the method of fishing in relation to size at sexual maturity, and post-catch mortality of the species.

In determining the risk for each species, susceptibility is more important than productivity. If a species has high productivity and low susceptibility, the risk is low. On the other hand, if the productivity is low and the susceptibility high, the risk is high. The results of this analysis indicate which of the species affected by the activity require management measures.

When the implementation of management plans does not diminish the level of risk for a particular species, the species

will be evaluated at Level Three. This level includes in-depth analyses such as the evaluation of population status, maximum sustainable catch levels, and reproduction and recruitment models.

The technical team implementing the ERAEF methodology in Galapagos includes scientists from various institutions involved in ecological and fisheries studies in the GMR, including the National Institute of Galapagos, the Spanish organization Instituto de Promoción y Ayuda al Desarrollo (IPADE), the University of Melbourne (Australia), Galapagos National Park, World Wildlife Fund, and the CDF. The results obtained thus far and summarized in this paper are those of the analysis of the deep sea sub-fishery.

Does the deep sea sub-fishery pose any threats? Are any species at risk?

The first step in the evaluation of the deep sea sub-fishery is to determine all of the units of analysis that form each ecological component. These analysis units serve as indicators of the effects of the activities evaluated at Level One and form the analytical base for Level Two. They include:

Ten target species (Table 1);

74 associated species, including fish and mollusks such as black jacks, conches, parrotfish, and moray eels;

73 PTE species, such as whales, dolphins, sharks, and marine birds;

16 habitat types (Table 2); and

15 types of marine communities (Table 3).

Table 1. Target species identified for the sub-fishery – deep sea fishing.

Family	Scientific name	Common name
Labridae	*Semicossyphus darwini*	Galapagos sheephead wrasse
Lutjanidae	*Lutjanus novemfasciatus*	Dog snapper
Malacanthidae	*Caulolatilus princeps*	Ocean whitefish
Scorpaenidae	*Pontinus clemensi*	Mottled scorpionfish
Serranidae	*Cratinus agassizii*	Grey threadfin bass
Serranidae	*Epinephelus mystacinus*	Misty grouper
Serranidae	*Mycteroperca olfax*	Galapagos sea bass (bacalao)
Serranidae	*Paralabrax albomaculatus*	White spotted sand bass
Carangidae	*Seriola rivoliana*	Jack

Source: Murillo *et al.* (2003) and Molina et al. (2004a and b).

Table 2. List of habitats in the GMR evaluated using ERAEF.

Location	Type of habitat	Cover	Depth (m)
Land	Coastline above sea level*	Not available	
Interior insular platforms (2 - 500 m)	Intertidal lagoons	Not available	0 - 2
	Coastal lagoons	Not available	1 - 2
	Sediment intertidal	Approximately 4,622,745 m^2	2 - 2
	Rocky intertidal	More than 80%	3 - 2
	Rock substrate	Not available	2 - 500
	Soft substrate	Not available	3 - 500
	Vertical walls	More than 50 walls considered important	4 - 500
	Hydrothermal crater	Not available	400 - 500
	Seamount	Not available	100 - 400
Exterior insular platforms (>500m)	Embankment or slope	No baseline	500 - 3 500
	Hydrothermal crater	Not available	> 2 000
	Deep rock substrate	No baseline	1000 - 3000
	Deep sediment substrate	No baseline	1000 - 3000
	Seamount	No baseline	400 - 1000
	Deep sea floor	No baseline	> 3000

* Includes all of the exposed areas of the islands above high tide.
Source: Based on Chadwick (2006), Banks (2007), and information from ecological monitoring by CDF (D. Ruiz, unpublished).

Table 3. List of communities under evaluation according to the biogeographical regions of the GMR.

Sub-biome	Vertical position	Name of community	Spatial location[1]				
			Elizabeth Bay	Far North	North	West	Southeast
Land	Supralittoral	Terrestrial organisms	x	X	x	x	x
Interior insular platforms - ~500 m)	Intertidal (0 - 2 m)	Mangroves or unsubmerged vegetation	x		x	x	x
		Intertidal meiofauna	x		x	x	x
		Rocky intertidal	x	X	x	x	x
	Subtidal (2 - 500 m)	Soft substrate benthos	x	X	x	x	x
		Rock substrate benthos	x	X	x	x	x
		Marcroalgae beds and kelps	f	F	f	x	f
		Hermatypic corals		X	f		f
		Filtering organisms		X	x	x	x
		Bentho-pelagic on seamounts					x
		Chemosynthetics				x	
Exterior insular platforms (>500 m)	Subtidal (~500 - 3 000 m)	Deep seafloor benthos	x	x	x	x	x
		Seamount bentho-pelagics		x	x		x
		Chemosynthetics		x			
	Abyss (> 3 000 m)	Deep sea benthos		x	x	x	x

1 The spatial location is coded as follows: x = present; f = fragmented; empty = absent.
Source: Based on Wellington (1975); Edgar et al. (2004); Chadwick (2007); and information from ecological monitoring by CDF (D. Ruiz, unpublished).

The Level One analysis indicates that this sub-fishery generates few impacts on habitats, but does impact target species and associated marine communities.

The activities assigned medium risk level are associated with weaknesses in or lack of attention to systems for quarantine, collection of organic and inorganic wastes, and fuel management and engine operation of fishing boats. The principal impacts of these activities are on the structure and functioning of habitats and species composition of communities. Bait collection is highlighted due to our lack of information related to the level of effort and its potential impacts. Since bait collection is highly connected with a second sub-fishery (fishing with nets), a study is needed to evaluate and manage the activity for both sub-fisheries.

Table 4. Summary of risk levels identified for direct and indirect activities in the deep sea sub-fishery, according to their ecological component.

Type of impact	Fishery activity	Target species	Associated species	PTE	Habitat	Community
Direct with catch	Obtaining bait					
	Fishing					
	Incidental behavior					
Direct without catch	Obtaining bait					
	Loss of fishing equipment					
	Anchoring					
	Navigation					
Addition or movement of biological material	Transfer of species					
	Onboard processing					
	Supplies					
	Organic wastes					
Addition or movement of non-biological material	Garbage					
	Fuel spills					
	Chemical pollution					
	Smoke					
	Loss of fishing equipment					
	Navigation					
	Presence in the water					
Disturbance of physical processes	Anchoring					
	Navigation					
Impacts outside of the sub-fishery	Trawl nets, nets, illegal fishing					
	Coastal development					
	Illegal fishing - tourism, subsistence, research					
	Tourism					
	Patrol and vigilence, shipping & research					

Risk level: - low. - medium. - high.

NOTE: External impacts are not considered within Level One analyses.

Fishing is the only activity that represents a high risk to target species primarily due to the potential impacts on Galapagos sea bass (bacalao) and sea bass (el mero). Level One results also showed a medium risk for some other species. The olive grouper, the leather bass, some shark species, penguins, and sea lions were highlighted during the process as indicator species. However, species analyses at Level Two indicated low susceptibility to this sub-fishery for all species (target, associated, or PTE).

Of the target species, only the Galapagos sea bass and sea bass have high and medium risk levels, respectively (Figure 2a), while the associated species all showed a low risk level to this fishing activity (Figure 2b).

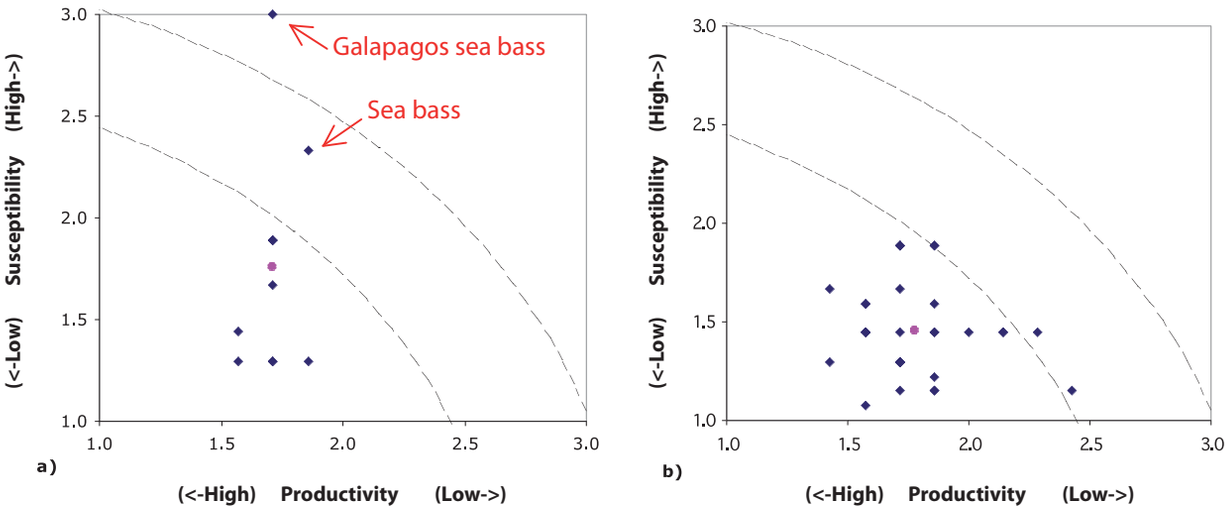

Figure 2. Results of the analysis of productivity and susceptibility for: a) target species, and b) associated species. The red point indicates the average value of productivity and susceptibility of each component analyzed. The broken lines indicate the limits of the risk zones: the lower line in each graph is the limit between low and medium risk and the upper line between medium and high.

Among bycatch species, species of eel, the coral reef cornetfish, and the yellow-tailed surgeonfish had a medium risk due to their productivity potential (Figure 3a). Of the PTE species, the majority were assigned a medium risk level, except flightless cormorants and torpedo rays, which were assigned high risk levels (Figure 3b). In spite of low productivity values, the susceptibility values of the bycatch and PTE species indicate that they are only slightly vulnerable to this fishery and thus of less concern for fisheries management.

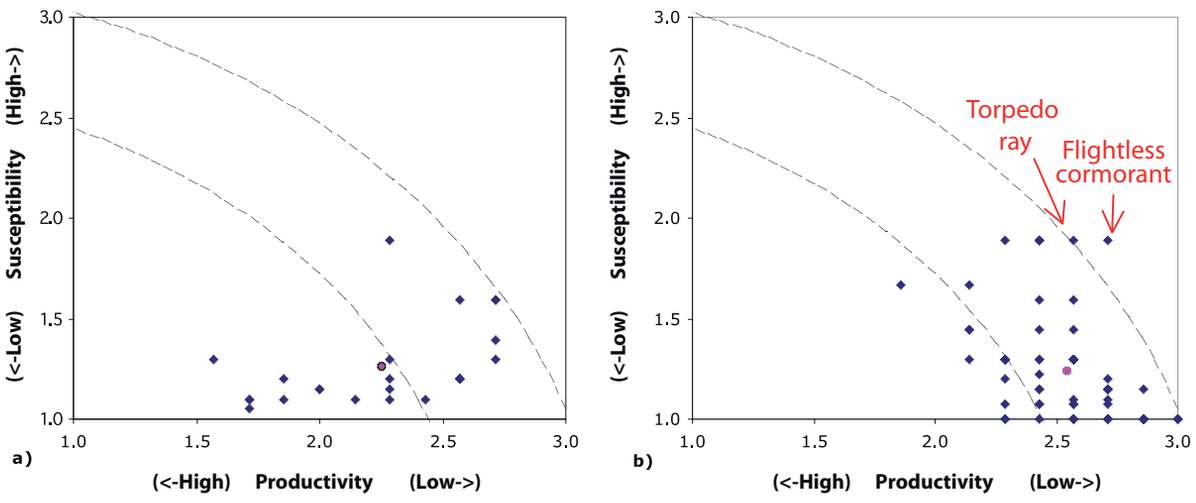

Figure 3. Results of the analysis of productivity and susceptibility for: a) discarded species, and b) PTE species. The red point indicates the average value of productivity and susceptibility of each component analyzed. The broken lines indicate the limits of the risk zones: the lower line in each graph is the limit between low and medium risk and the upper line between medium and high.

Photograph: Alex Hearn

What is the next step?

The EREAF process shows that the deep sea sub-fishery is very "clean" in comparison to other fisheries worldwide, such as longlining, dredges, and trawl nets (Morgan and Chenpadgee, 2003). However, on the basis of the results from Level One, we strongly recommend a revision of the quarantine process for ships to avoid the problems of introduction of rodents, insects, and plants (Calvopiña, 1991; Roque-Albelo et al., 2006; Coronel, 2007). We also recommend reinforcing and improving fuel management systems and general maintenance of ships and ship engines in order to reduce pollution from hydrocarbons and heavy metals from marine paints (Cubero et al., 2007). In the case of the Galapagos sea bass (bacalao) and sea bass (el mero), both analyzed at Level Two, additional studies (Level Three of EREAF) are necessary to evaluate the current status of these species and to develop appropriate management plans.

In addition, we recommend that more emphasis be placed on filling information gaps encountered during the analysis. Specifically, additional knowledge is needed regarding:

- Selectivity of catch size for fishing methods used in the GMR (important for establishing regulations regarding catch size);

- Impacts of the selective removal of the most exploited species within this fishery;

- Bycatch species and their post-catch mortality;

- Dynamics and distribution of bait collection;

- Level of contamination by metals of species that live nearest to populated areas; and

- Status of the marine environment vis-a-vis the introduction of invasive species.

The process of applying ERAEF has been underway for approximately one year. While the first step is completed, the evaluation of the minor pelagic sub-fishery and net sub-fishery still remain to be done. Complementary studies have highlighted illegal fishing and tourism as activities that pose potential threats to PTE species and marine communities. We recommend a broader application of this analytical tool to evaluate the impact of these activities and to focus management responses on areas with the greatest identified threats.

The consequences of herbivore eradication on Santiago: are we in time to prevent ecosystem degradation again?

Rachel Atkinson, Jorge Luis Renteria & Walter Simbaña

Charles Darwin Foundation

Introduction

Santiago Island in the north of the archipelago is the second largest of the uninhabited islands. Its size (58 465 ha) and altitude (908 masl) have led to the formation of many vegetation types with a rich biodiversity including single island endemics.

The unique flora and fauna were devastated during 100 years of herbivory by goats, pigs, and donkeys. Following many attempts, a concerted effort finally eradicated pigs in 2001, donkeys in 2004, and goats in 2006 (Carrion *et al.*, 2007; Cruz *et al.*, 2005; Lavoie *et al.*, 2007). Free of the major threat to the biodiversity, natural ecological and evolutionary processes were expected to resume (Lavoie *et al.*, 2007). As predicted, the island's vegetation is recovering, and the populations of three highly threatened island endemic plant taxa, *Galvezia leucantha* subsp. *porphyrantha* Tye and H. Jäeger, *Scalesia atractyloides* Hook f., and *Scalesia stewartii* Riley are increasing (Tye, 2000; Tye and Jäger, 2000; Tye, 2007).

The Galapagos snap-dragon (*Galvezia leucantha* subsp. *porphyrantha)* was known from three populations in 2000, comprising about 130 plants (Tye and Jäger 2000). Two of these populations were fenced to protect them from herbivores. A total of six populations are now known and surveys of five of these in 2007 recorded 220 plants, 63 of which were located outside the fences (Simbaña, W. CDF, unpubl data).

Scalesia atractyloides was feared extinct until a few individuals were rediscovered in the 1990s (Tye and Jäger, 2000). The species has two distinct varieties. One variety, reduced to two adults, is now known from four locations, and monitoring at one location in 2007 recorded 21 plants. Five plants of the second variety were rediscovered in 1995 (Tye and Jäger, 2000). It has since been found in twelve sites and monitoring of eleven of these in 2007 recorded 1404 adults and over 2000 young plants. The fast recovery of these species and the predicted long term effect of herbivore eradication has led to the proposal to move each of these taxa into IUCN categories of lesser threat (Tye, 2007).

However, ecosystem degradation is a complex process and is rarely caused by a single introduced species. Eradication of what may seem to be the principal invasive changes the system dynamics and interactions between species. Rather than resulting in a reversal of the degradation process, this can lead to unwanted secondary consequences. Thus although eradications can have very successful outcomes, they can also have unexpected and undesirable effects, which, if not mitigated, can lead to problems as difficult and expensive to reverse as the initial eradication (Zavaleta *et al.*, 2001; Zavaleta, 2002).

During the final stages of goat eradication, one of the worst invasive plants in the archipelago was found in the highlands of the island. The species, *Rubus niveus* (blackberry), originates from the Himalayan region of India and was introduced to San Cristóbal in the 1970s for its fruit. It is now a serious problem in the highlands and agricultural zones of San Cristóbal and Santa Cruz and is becoming established in Isabela (Sierra Negra and Cerro Azul volcanoes), Santiago, and Floreana (Renteria *et al.*, 2007).

Blackberry is fast growing, forming dense impenetrable thickets that prevent native forest regeneration. It produces fruit at about six months of age and can reproduce vegetatively by suckers. Although most fruit fall from the plant, they are also dispersed by fruit-eating birds, mammals, and reptiles. Seeds can remain in a dormant phase in the soil for at least 10 years, and although germination is stimulated by light, the species can also tolerate shade (Hughes, 2002).

The combination of these factors makes control of blackberry difficult. Once it has produced seed and begun to form a seedbank, the species is very hard to remove from the environment. Just to prevent its spread requires repeated and frequent monitoring and control of new infestations. In addition the plants are hard to find amongst other vegetation and by the time they are spotted they are usually bearing fruit.

It is unclear when blackberry reached Santiago. Control began in 2006, with a systematic approach beginning in 2007. This has involved regular control of known infestations using an herbicide and systematic searching of surrounding areas to locate new plants. Helicopter surveying along transects has also been carried out several times and is proving to be an efficient method of detecting adult plants outside of known areas of distribution.

This paper reviews the distribution and abundance of the invasive blackberry in Santiago, evaluates whether eradication is still possible and whether there is still time to avoid another degradation event.

Methods

Systematic control of the known infestations and monitoring for new plants or infestations of blackberry were carried out during eleven field trips to Santiago in 2007.

The known infestations were controlled every three months. Intensive searching using equidistant points at a distance of 5 m apart were carried out in defined zones around each of the main infestations. In addition, a systematic helicopter search over part of the area was completed once. The plants located were subsequently controlled and areas around these new plants searched systematically. The life history stage of all plants found was also recorded.

Results

By the end of 2007, blackberry was known to cover 28 ha, located in four sites: La Naranja (15 ha), Pampa Larga (6 ha), La Reina (4 ha), and La Muela (3 ha) (Figure 1). Systematic searching of an additional 260 ha surrounding these zones resulted in 63 new plants, the majority of which were found immediately surrounding the four large infestations, although some were found at the maximum distance searched from each infestation (500 m).

A total of 2 760 plants were found and controlled over the five repeat visits of which 94 were adults bearing fruit. Plants both with and without fruit were found each time the areas were revisited, with

no trend of decreasing abundance over time, indicating the enormous size of the seedbank (Figure 2).

Of the 63 plants found surrounding the known infestations, 12 were with fruit. Most of the fruiting plants were first spotted at a distance or from the helicopter rather than during transect monitoring.

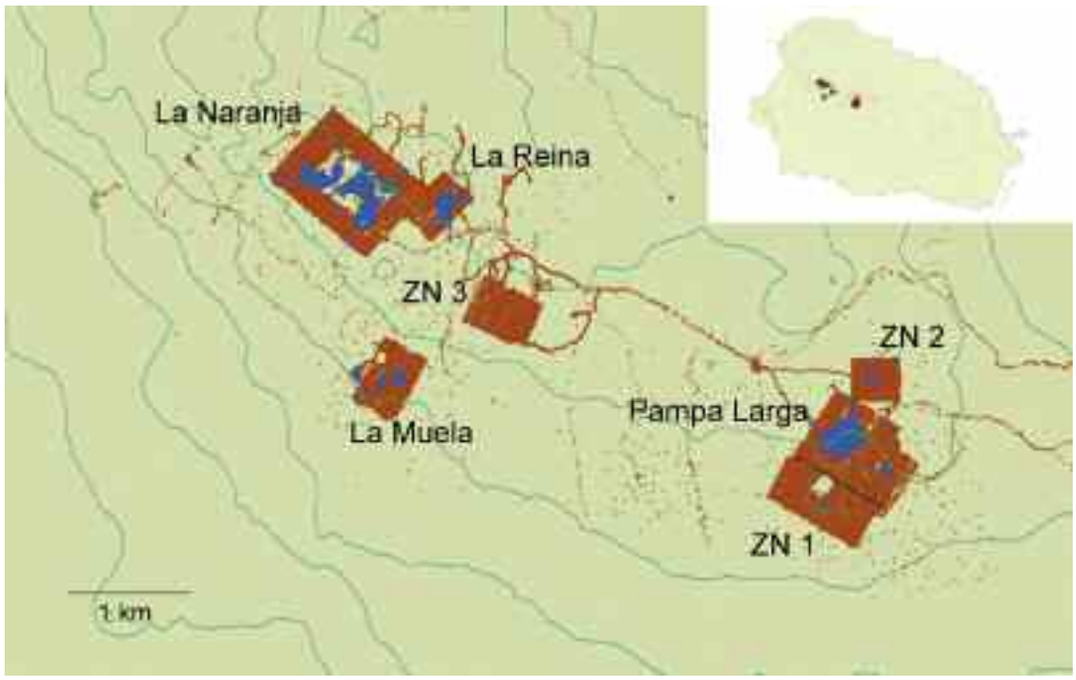

Figure 1. Zones of infestation of blackberry in the highlands of Santiago. Areas searched using equidistant points are in brown and blackberry locations in blue.

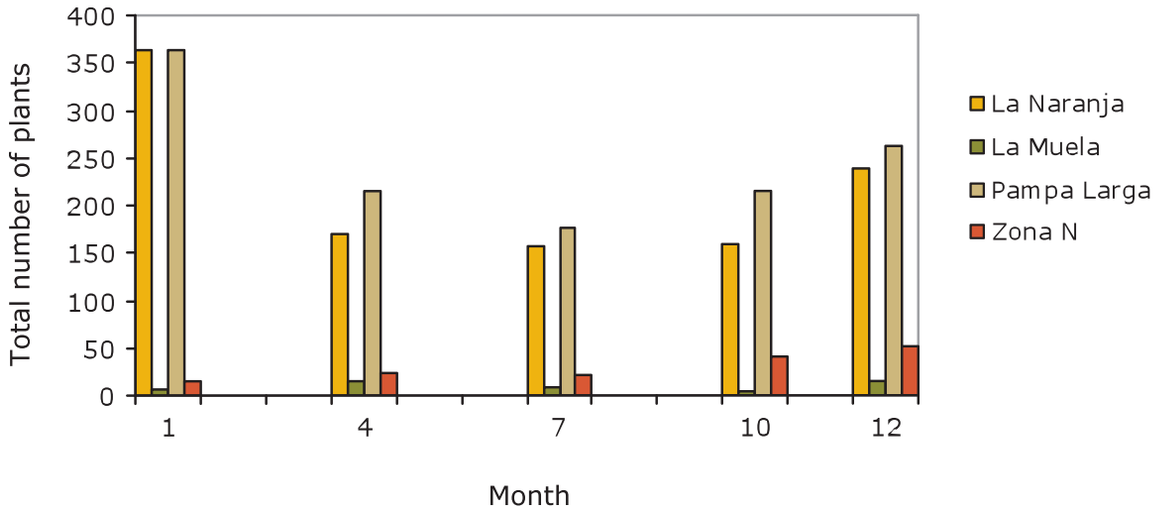

Figure 2. The number of plants found in each of the main infestations during the five controls carried out in 2007.

Discussion

While it is obvious that the eradication of introduced herbivores from Santiago has had a significant and positive effect, an alarming consequence has been the establishment of the introduced blackberry in the highlands of the island. The species is now known to cover at least 28 ha. It has a huge and viable seedbank in these areas and the presence of adult plants outside of the main infestations suggests that the species has a much wider and as yet unknown distribution that will continue to increase through seed dispersal.

On Santa Cruz and San Cristóbal, the

humid zone is nearly dominated by blackberry but it is rarely found in transition zone vegetation (CDF unpublished). Thus it can be predicted that all of the humid uplands of Santiago would be suitable for its growth, a potential area of about 4000 ha (Figure 3). Under climate change models it is likely that Galapagos will experience increased precipitation (Mitchell *et al.*, 2003). This will increase the potential area available for invasion by blackberry in the future.

Figura 3. Habitat zone predicted as suitable for blackberry expansion (shown in blue); based on maps by Pronareg, Orstom and Ingala (1987).

It is clear that if this species is going to be eradicated from Santiago, more intensive survey and control methods must be developed and implemented. These include surveying on horseback or helicopter to cover the whole of the humid zone every three to six months. This will ensure that every plant is detected before it produces fruit so that a seedbank does not become established. At the same time, the established infestations have enormous seedbanks that will continue to germinate over the next 10-15 years. Seedbank control methods that prevent germination or growth need to be implemented. This will help to reduce the persistence of this species in the ecosystem.

With this combination of techniques, it is estimated that eradication could be achieved within 15 years, at an estimated cost of US$150 000 per year, totalling US$2.25 million. Although this appears to be less costly than eradication of goats at US$5.5 million (Lavioe *et al.*, 2007), blackberry is only found in the humid zone. Thus, on a per hectare basis, its eradication will cost six times that of goat eradication.

The release of the introduced blackberry from herbivory clearly shows that the use of single-species eradications for ecosystem restoration is only a first step in a long-term process. Carrying out a risk analysis to predict any negative consequences of the eradication beforehand, developing a funded contingency plan, and monitoring the ecosystem after eradication has been completed are essential steps to ensure that a rapid response to any new threat can be instigated before the ecosystem begins to degrade again. This does not mean that single species eradications should not take place but that careful planning is necessary to avoid the negative consequences to restoration.

Pathogens and parasites: an increasing threat to the conservation of Galapagos avifauna

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Introduction

Today there is much interest in the impacts of disease on wildlife conservation in general, on island populations, and more recently on the avifauna of Galapagos. Diseases, both non-infectious and infectious/parasitic, have been shown to cause illness and death in Galapagos birds. Furthermore, the expanding poultry industry poses a threat to wild bird populations through the introduction of poultry pathogens, which may be highly infectious for the immunologically naïve native birds. In addition to the disease agents currently present in Galapagos, many new pathogens and parasites may soon arrive. Preventive measures to minimize their introduction are imperative.

Invasive pathogens and parasites can arrive in Galapagos by the same routes as other invasive species (plants, vertebrates, and invertebrates): on boats and planes or hidden in food items and materials (Causton, 2007) or via vertebrate species intentionally imported, which may harbor pathogens (e.g., day-old chicks). The true threat of these introduced pathogens in Galapagos is unknown. However, in other island systems, such as Hawaii, we know that introduced pathogens have caused avian extinctions.

There are 88 species of birds registered in Galapagos, 56 of which breed in the islands and 45 of which are endemic (Wiedenfeld, 2006). Fifteen of the native avian species have populations of less than 1500 individuals and/or are restricted to a single island. Both of these factors put these species at increased risk of disease-related extirpations or extinctions.

Avian pathogens and parasites of concern for Galapagos birds

Of 16 pathogenic and parasitic agents considered of high concern for conservation of wild birds in Galapagos, nine are already present and seven have

not yet arrived (Table 1). Eleven pathogens to which wild birds are susceptible have already been found in domestic poultry in the archipelago (Table 2).

Avian pathogens and parasites currently in Galapagos

Avian pox virus

Avian pox virus is mechanically transmitted by a number of vectors (e.g., mosquitoes and biting flies) or by contact through any break in the skin. Disease associated with this virus can be mild to highly pathogenic depending on virus strain and host species. In Galapagos, nine species of wild birds exhibit symptoms consistent with pox virus infection (Jiménez-Uzcátegui *et al.*, 2007). Mockingbirds appear to be the most severely affected (Figure 1) and can experience high mortality. The results of a recent molecular analysis indicate the presence of at least two strains of canary poxvirus present in wild birds in Galapagos and a third poxvirus, fowl poxvirus, present in chickens (Thiel *et al.*, 2005).

Philornis downsi

In 1997, an obligate dipteran bird parasite *Philornis downsi* was documented in nestling Darwin's finches on Santa Cruz Island (Fessl and Tebbich, 2002). The life cycle of this fly includes a parasitic larval stage (Figure 2a), which feeds on nestling birds (Figure 2b), and a free-living adult. Small broods suffer higher parasite loads per nestling than larger broods and therefore higher nestling mortality (Dudaniec and Kleindorfer, 2006). In addition to direct nestling mortality (up to 97%), studies have confirmed that some surviving nestlings of Darwin's finches have reduced growth rates, anemia, and may suffer permanent physical damage (Dudaniec *et al.*, 2006; Fessl *et al.*, 2006).

Poultry diseases

The poultry industry in Galapagos has rapidly expanded in recent years in response to the increasing human population. An estimated 143 000 day-old chicks were imported from the mainland to the archipelago in 2005; with an increase to 320700 in 2007 (SESA, unpub data). These imported chicks represent a frequent potential route for pathogens to enter the islands. However, in one study it was shown that free-living "backyard" chickens harbor more pathogens than the day-old chicks and adult broiler chickens (Soos *et al.*, 2008). The first indication of the threat posed by imported poultry was a 1995-96 Marek's epidemic (Vargas and Snell, 1997), a viral infection of high pathogenicity for both domestic and wild birds. More recently, two studies have documented a number of pathogens in both enclosed and free-roaming chickens (Table 2) (Gottdenker *et al.*, 2005; Soos *et al.*, 2008).

Introduced vectors

Many species of mosquitoes, flies, and ticks serve as mechanical and biological vectors for the transmission of avian pathogens. The recent establishment of the mosquito *Culex quinquefasciatus*, a good mechanical vector of avian pox and a vector for two important pathogens that have not yet been recorded in Galapagos, West Nile Virus (WNV) and *Plasmodium relictum* (avian malaria), is one example of an invasive invertebrate with potential significant impacts on avian health (Whiteman *et al.*, 2005).

Miscellaneous avian pathogens and parasites

A number of studies in Galapagos have confirmed the presence of avian pathogens (Table 1) but the current threat to Galapagos birds is unknown (reviews in Parker *et al.*, 2006; Padilla and Parker, 2007). There have also been many studies on the ectoparasites of Galapagos birds (reviews in Parker *et al.*, 2006; Padilla and Parker, 2007). Many of these parasites have health costs, best exemplified by the Galapagos hawk in which decreased immunologic status and higher parasite loads have been demonstrated for the

smaller populations residing on small islands (Whiteman *et al.*, 2006).

Avian pathogens and parasites that may soon arrive to Galapagos

Avian influenza (H5N1)

The threat of spread of H5N1 from the epidemic in the Old World to the Americas is of international concern due to its human pandemic potential, huge economic costs, and pathogenic effects on wild birds. Today over 30 wild bird species have been confirmed positive with H5N1 avian influenza (Redrobe, 2007). If H5N1 were to arrive in Galapagos, it would likely be devastating for both the endemic and commercial avian species, as well as for the tourism trade.

Avian malaria

Plasmodium relictum is an avian malarial parasite that can induce severe anemia and death in many avian species and has been a key factor in Hawaiian bird extinctions (Warner, 1968). It has yet to be identified in any Galapagos avian species. However, there is grave concern as a number of birds in the archipelago are thought to be highly susceptible and the mosquito *C. quinquefasciatus*, a known vector for this parasite, is now established in the archipelago. Additionally, the finding of a *Plasmodium* parasite in the Galapagos penguin is another recent concern. This parasite appears to be distinct from other *Plasmodium* species, including *P. relictum*, known to cause avian malaria, but studies are currently underway to identify this parasite and its impact more precisely.

West Nile Virus

West Nile Virus (WNV), which is spread by mosquitoes and pathogenic to birds, humans, and horses, has caused significant loss of life in the United States since arriving in New York City in 1999. In less than 10 years it has spread west across North America and south into the Caribbean and Latin America. In the New World, WNV has been detected in over 200 avian species (Komar, 2003). A risk analysis for WNV introduction to Galapagos found that infectious mosquitoes, transported on airplanes, represent the highest risk of arrival (Kilpatrick *et al.*, 2006).

Miscellaneous avian pathogens

There are a number of pathogens that have significant impacts on wild bird health. In Galapagos, there is continual concern about avian diseases such as *Toxoplasma gondii*, *Salmonella* spp., cholera, and botulism (Wikelski *et al.*, 2004).

Current research and management efforts for the health of avifauna in Galapagos

Many dedicated scientists are working in Galapagos to better understand and minimize the disease threats to the avifauna. Studies include: (i) baseline data collection; (ii) population health monitoring; (iii) specific pathogen studies; (iv) vector studies; (v) necropsy database of all submitted dead birds; and (vi) health studies related to specific conservation efforts such as the re-introduction of the Floreana mockingbird (*Nesomimus trifasciatus*) to Floreana. A number of Galapagos avian health workshops have been held during the past decade and a disease risk analysis workshop, which will provide an objective prioritization of diseases threatening Galapagos avifauna, is scheduled for the coming year.

Preventive measures have been implemented to halt the introduction of new pathogens, including spraying of incoming airplanes for vector control and control of domestic animals coming to Galapagos. Stronger measures are warranted, including increased biosecurity and proper husbandry/veterinary care for poultry farms, the elimination of cock fighting, backyard poultry operations and all domestic Anatidae. Veterinary diagnostic capabilities for wild bird species are available at the Galapagos Genetics, Epidemiology, and Pathology Laboratory (GGEPL) but current capacity has been exceeded and there is little capacity for agricultural (e.g., poultry) veterinary needs.

The conservation of the avifauna of Galapagos is imperative for ecosystem health, as birds serve many ecological roles. Additionally birds are one of the most popular attractions drawing tourists to Galapagos. Lastly many avian pathogens are zoonotic (affecting humans and birds) and cross the wildlife (free-ranging birds) - domestic (poultry) animal "divide": these pathogens have ecologic, human health, and economic impacts. Therefore we must strive to minimize infectious diseases in the avifauna of Galapagos to ensure not only the health of the ecosystem and the avian species, but also that of the humans.

Table 1. Pathogenic and parasitic agents currently known, or feared to soon arrive, in wild birds in the Galapagos.*

Parasite	Species**	Islands**	Risk rating***
Philornis downsi	CA, CM, COA, CPA, CPL CPS, GFA, GS, MP, PR, GFT	CHP, DM, FER, FL, GBF, ISA, MAR, PZ, SCB, SC, STO	High
Avian pox virus	CPA, CPL, DP, GFA, GFT, GG, GMS, GS, MP, PCS	CHP, FL, ISA, SCB, SC	High
West Nile Virus	NONE****	NONE	High
Plasmodium relictum	NONE	NONE	High
H5N1	NONE	NONE	High
Chlamydophila psittaci	NPH, SMS, ZGS	ESP, FER, ISA	Medium
Adenovirus	DIT, NPH	ESP, FER, ISA	Medium
Microfilariae	NPH, SMS	FER, ISA	Medium
Botulism	NONE	NONE	Low-Medium
Avian cholera	NONE	NONE	Low-Medium
Trichomonas gallinae	CL, ZGS	SCB, SC	Low-Medium
Hemoproteus	FM, SS, CFS, SMS, ZGS	ESP, GEN, SC, SFE, STO, SC	Low
Trypanosome sp.	BGS	STO	Low
Isospora spp.	GFA, GFT	FL, SC	Low
Toxoplasma gondii	NONE	NONE	Low
Salmonella spp.	NONE	NONE	Low

*This is not an exhaustive list but highlights disease agents currently believed to be of highest overall conservation concern.
**Galapagos species and islands are based on current data but this does not preclude the potential for the presence of disease agents in other species or islands.
Species: BGS - *Buteo galapagoensis* (Galapagos hawk); CA - *Crotophaga ani* (Smooth-billed ani); CFS - *Creagrus furcatus* (Swallow-tailed gull); CL - *Columbia livia* (Rock dove); COA - *Certhidea olivacea* (Warbler finch); CM - *Coccyzus melacoryphus* (Dark-billed cuckoo); CPA - *Camarhynchus psittacula* (Large tree finch); CPL - *Camarhynchus pallidus* (Woodpecker finch); CPS - *Camarhynchus parvulus* (Small tree finch); PBI - *Phoebastria irrorata* (Waved albatross); DP - *Dendroica petechia* (Yellow warbler); FM - *Fregata minor* (Great frigatebird); GG - *Gallus gallus* (Domestic chicken); GFA - *Geospiza fuliginosa* (Small ground finch); GMS - *Geospiza magnirostris* (Large ground finch); GFT - *Geospiza fortis* (Medium ground finch); GS - *Geospiza scandens* (Cactus finch); MP - *Nesomimus parvulus* (Galapagos mockingbird); NPH - *Nannopterum harissi* (Flightless cormorant); PCS - Platyspiza crassirostris (Vegetarian finch); PR - Pyrocephalus rubinus (Vermillion flycatcher); SMS - *Sphieniscus mendiculus* (Galapagos penguin) ; ZGS - *Zenida galapagoensis* (Galapagos dove); SS - *Sula sula* (Red-footed booby).

Islands: CHP - Champion; DM - Daphne Major; ESP - Española; FER - Fernandina; FL - Floreana; GBF - Gardner by Floreana; GEN - Genovesa; ISA - Isabela; MAR - Marchena; PZ - Pinzón; SCB - San Cristóbal; SC - Santa Cruz; SFE - Santa Fe; STO - Santiago.

***Risk rating is based on a subjective assessment of known virulence, susceptible species, transmission dynamics, and epidemiology in Galapagos and elsewhere. All the pathogens in this table are in the "highest overall conservation concern" category with the risk rating a comparison of these pathogens/parasites with each other.

**** NONE – indicates that the pathogen or parasite has not yet been identified as present.

Table 2. Pathogens and parasites detected in domestic poultry in Galapagos.

Pathogen/ Parasite	Risk Rating*
Avian paramyxovirus-1	High
Mycoplasma gallisepticum	High
Marek's disease virus	High
Adenovirus-1	Medium
Chlamydophila psittaci	Medium
Infectious laryngotracheitis virus	Medium
Infectious bronchitis virus (Mass)	Medium
Infectious bronchitis virus (Conn)	Medium
Infectious bursal disease virus	Medium
Reovirus (infectious tenosynovitis virus)	Low
Avian encephalomyelitis virus	Low

*Risk rating is based on a subjective assessment of known virulence, susceptible species, transmission dynamics, and epidemiology in domestic and wild birds world-wide.

Figura 1a. Juvenile Galapagos mockingbird (*Mimus parvulus*) on Santa Cruz Island with severe pox lesions (photo courtesy of Sharon Deem).

Figura 1b. Figure 1b. Galapagos mocking-bird with severe pox lesions on its head (photo courtesy of Andrew Hendry).

Figure 2a. *Philornis downsi* larvae in a Darwin's finch nest (photo courtesy of Andrew Hendry).

Figura 2b. Dead Darwin's finch nestling with *Philornis downsi* larvae-induced deformation to nares (photo courtesy of Sarah Huber).

Perceptions of the status of the white fish fishery in the Galapagos Marine Reserve

Mauricio Castrejón

Charles Darwin Foundation

Introduction

The white fish fishery is of historical socioeconomic importance for fishermen in the Galapagos Marine Reserve (GMR). Today approximately 68 species are fished, with mullet, wahoo, yellow-finned tuna, jack, and Galapagos sea bass the most abundant in the catch (Peñaherrera, 2007). The most common method is hand line fishing, with multiple hooks. Unfortunately, the lack of both economic and human resources has resulted in limited scientific knowledge regarding the current status of the fishery. In response to this, a method known as "Participatory Fisheries Stock Assessment" (ParFish) was adapted to Galapagos conditions and used in this study. This method was developed by scientists from the Marine Resource Assessment Group (MRAG) and has been applied recently in diverse sites of Asia and Africa, where scientific data is limited or non-existent, to evaluate small-scale, artisanal fisheries for the development and implementation of co-management systems (Walmsley *et al.*, 2005). ParFish engages the users of the resource at each stage of fisheries management (evaluation, planning, decision-making, and implementation). Management impacts are analyzed and evaluated periodically to reformulate both management plans and actions. In this study, the ParFish method was used to produce a rapid and cost-efficient evaluation of the white fish fishery, based on Local Fisherman Knowledge (LFK). The LFK is understood as an accumulative body of knowledge, practices, and beliefs, generated by the fishers of Galapagos through their observations and experience while fishing.

Methods

To evaluate the status of the white fish fishery in the GMR, the research focused on answering the following questions:

1) How much could a fisherman catch (in pounds) during a single day of fishing during the initial phase of commercial exploitation (unexploited catch rate), which occurred from the 1940s to the 1960s?

2) How much does a fisherman catch today (in pounds) in a single day of fishing (actual catch rate)?

3) What is the minimum catch that a fisherman must obtain per day (in pounds) to consider the white fish fishery profitable (minimum acceptable catch rate)?

4) Do the fishermen perceive year-to-year changes in their catch rate?

5) What is the perception regarding the current level of fishing (total fishing effort) for white fish?

Fifty-five interviews were conducted with fishermen between June and November 2006, 25 in Puerto Baquerizo Moreno and 27 in Puerto Ayora (Table 1). A random stratification sampling method was used, with a sample size greater than 10% of the active fishermen (for more detail, see Castrejón, 2008). Estimates for both unexploited and actual catch rates were based only on those cases where hand lines were the principal fishing method used. Non-parametric statistical analyses were used to evaluate significant differences among unexploited, actual, and minimum acceptable catch rates, by fishing port. The comparative measure used for these analyses was the median, not the average.

Table 1. Sample questions asked during interviews, including the type of information generated and the associated indicator.

Question	Information Obtained	Indicator
1. What method of fishing (hand line with multiple hooks, single hook hand lines, nets, etc.) are you most familiar with and use on a regular basis?	Types of fishing methods used most frequently	Principal fishing method
2. Currently, how many pounds of white fish do you normally catch in one day of fishing?	Actual catch rate during 2006	Actual catch rate
3. During recent years, has your catch rate remained the same, declined, or increased?	Perception of long-term changes in catch rate	Trends in catch rates
4. If you fished in a new fishing area (an area that had never been fished or was closed to fishing and then reopened after a certain length of time), what is the maximum number of pounds of fish that you think you could catch in a single day of fishing?	Perception of the maximum unexploited catch rate obtained during the initial phase of exploitation of the fishery	Unexploited catch rate
5. Do you believe that the actual level of fishing for the current size of the fish populations is: insufficient (could be greater), adequate, or too much?	Perception of the actual level of fishing effort in the white fish fishery	Actual level of fishing effort
6. What is the minimum number of pounds of fish per fishing day below which you would no longer consider it worth your while to continue fishing and would prefer to change your activity from fishing to something else?	Minimum catch rate that is considered sufficiently profitable for a fisherman to engage in fishing activities	Minimum acceptable catch rate

Results and discussion

Unexploited, actual, and minimum acceptable catch rates

Perceptions regarding the unexploited catch rate were highly variable. However, during the initial phase of exploitation, a fisherman using a hand line should have been able to catch an estimated 400 to 700 pounds of fish per fishing-day (Figure 1).

The catch rate in 2006 varied between 100 and 175 pounds/fisherman/fishing-day, significantly less than the unexploited catch rate (Figure 1). This range in values is similar to that reported by Reck (1983),

who estimated that between 1977 and 1981, the average catch rate using a hand line ranged from 94.6 to 143 pounds/fisherman/fishing-day. Although the reduction in catch rate from the initial phase of exploitation to the current situation is significant, the possibility exists that catch rates have remained stable from 1977 to 2006, and the demonstrated reduction is actually due to a combination of the increasing diversity of fishes caught and the fact that fishing effort for white fish has declined due to tourism and the expansion of both the lobster and sea cucumber fisheries in the mid 1980s to 1990s (Castrejón, 2008).

The actual and minimum acceptable catch rates differed significantly in both ports. The minimum acceptable catch rate ranged from 50 to 90 pounds/fisherman/fishing-day (Figure 1).

According to these figures, the actual catch rate remains at an economically profitable level for the fishermen. The minimum acceptable catch rate could be considered a reference point below which exploitation of the resource is considered undesirable and a level at which management measures should be implemented to permit the recovery of the fishery.

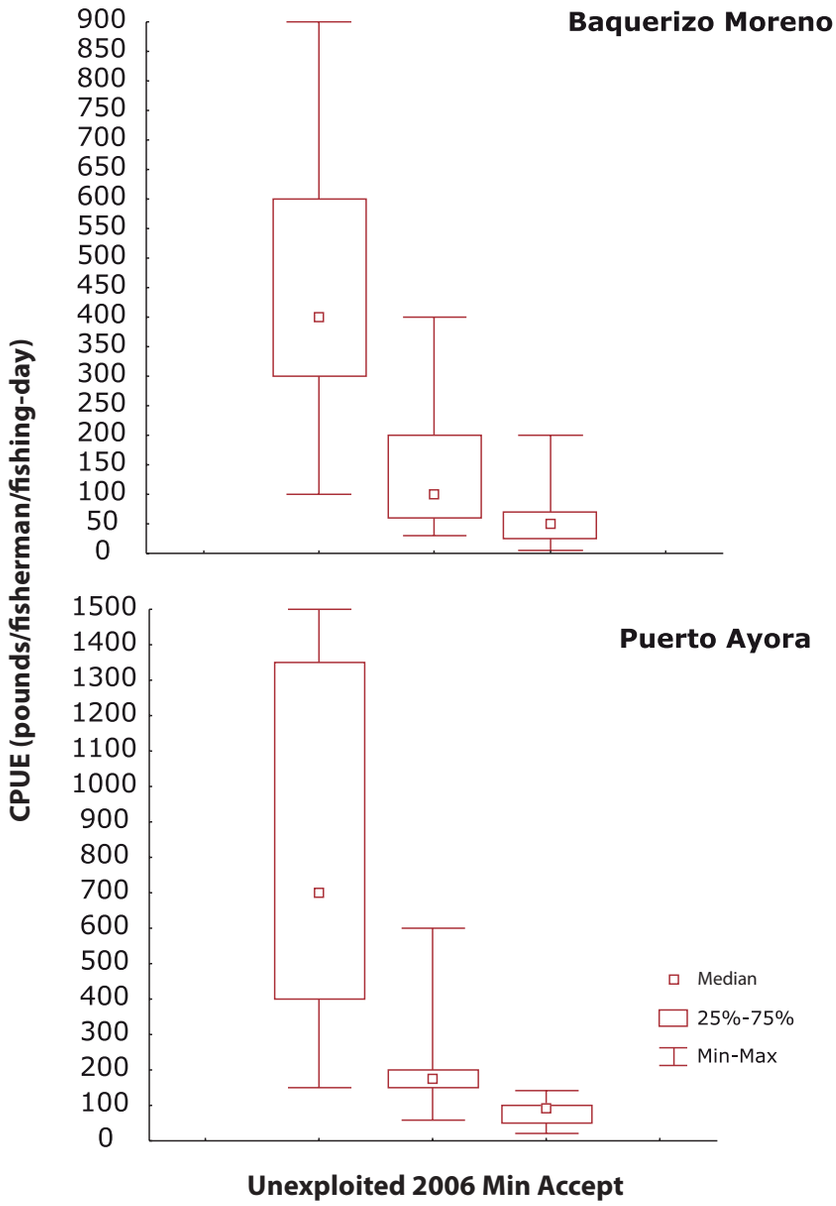

Figure 1. Comparison of the unexploited, actual (2006), and minimum acceptable (Min Accept) catch rates (in pounds/fisherman/fishing day), recorded in Puerto Baquerizo Moreno and Puerto Ayora. Note: estimates for the unexploited and actual catch rates are based only on those cases where a hand line was the principal fishing method used.

Trends in fishing levels

In Puerto Baquerizo Moreno, the majority of the fishermen interviewed believe that their actual catch rates have declined (64%), while in Puerto Ayora the majority believe that they have remained the same (46%, Figure 2). However, between 12 to 14% believe that their catch rates vary greatly, declining or increasing depending upon conditions at sea. There are also differing perceptions in the two ports regarding the total fishing effort (Figure 3). In Puerto Baquerizo Moreno, the majority consider that the current total fishing effort is adequate (50%), while in Puerto Ayora the majority believe that it is insufficient and could be increased (48%). These results demonstrate the differences in perception between the two ports regarding the current state of the white fish fishery and raise the following two questions:

1) Why do a higher percentage of fishermen in Puerto Baquerizo Moreno, in relation to the percentage in Puerto Ayora, believe that their catch rates have declined?

2) Why do the majority of fishermen in Puerto Ayora believe that the total level of fishing could be increased while those in Puerto Baquerizo Moreno think that current levels are adequate?

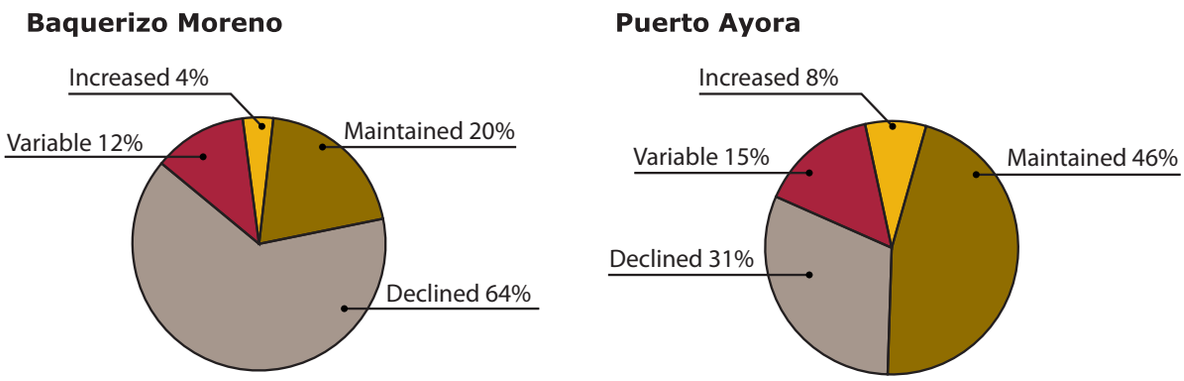

Figure 2. Trends in the catch rates of white fish (in pounds/fisherman/fishing-day), without regard to fishing method, according to the perception of the fishermen of Puerto Baquerizo Moreno and Puerto Ayora.

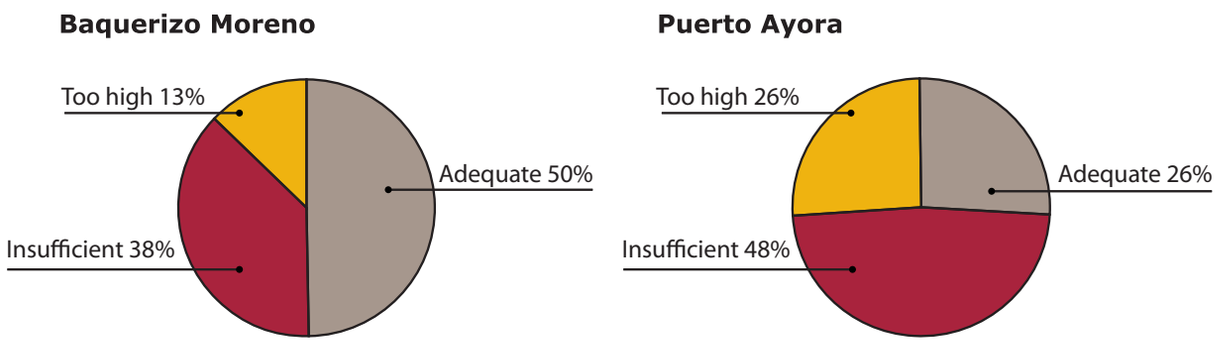

Figure 3. Perception of fishermen regarding the total level of fishing effort in the white fish fishery in Puerto Baquerizo Moreno and Puerto Ayora.

It is possible that a greater percentage of fishermen from Puerto Baquerizo Moreno believe that catch rates have declined because they specialize in catching different types of fish species with different life histories and levels of exploitation than do the fishermen in Puerto Ayora. In Puerto Baquerizo Moreno, fishermen have historically fished demersal fishes (sea bass of Galapagos, hawk fish, etc.), for which the risk of overexploitation is probably greater than it is for coastal-pelagic species (Reck, 1983). In Puerto Ayora, on the otherhand, fishing as a livelihood has a shorter history and it appears that the fishermen concentrate on the coastal-pelagic species (tuna, wahoo, etc.), with the goal of satisfying the local demand from restaurants and tourist boats. The level of abundance of this type of species is probably greater than that of demersal fishes, because the historical levels of exploitation have been lower (Castrejón, 2008). Therefore, it is possible that the perception of trends in catch rates of demersal fishes held by the fishermen of Puerto Baquerizo Moreno are directly related to population levels of those species, while the perceptions of the fishermen from Puerto Ayora are probably associated with the coastal-pelagic fishery. This can explain why the majority of fishermen of Puerto Baquerizo Moreno perceive that their catch rates have declined, while those in Puerto Ayora think they have remained at the same level over the years.

In Puerto Ayora, the majority of fishermen believe that their level of fishing effort for coastal-pelagic species can still be increased, while those in Puerto Baquerizo Moreno believe that the current level of fishing effort directed toward demersal fishes is adequate, given that they believe that their catch rates have been declining.

RECOMMENDATIONS

Considering the above hypotheses, a more detailed follow-up study is recommended to focus on which types of species are exploited in each port. The white fish fishery should be evaluated as two sub-fisheries: the demersal fish fishery using a hand line and the coastal-pelagic fishery, which uses all of the other fishing methods found in the GMR (nets, lures, etc.). Simultaneous evaluations of the spatial dynamics of the principal species that make up the white fish fishery and of the fishing fleet are also indispensable. For this a systematic collection of more biological-fishery data is needed to reduce the level of doubt currently existing regarding the current status of the demersal and coastal-pelagic sub fisheries. This type of research will provide a better basis for understanding the difference in perceptions between the fishermen of San Cristóbal and those of Santa Cruz regarding the white fish fishery in the GMR.

Finally, this type of research should be expanded to include marine resources with lower economic values than the spiny lobster, white fish, and sea cucumbers (such as slipper lobsters and minor benthic resources) for which there is a total lack of both historical and current knowledge regarding levels of exploitation.

Cryptogams of the Galapagos Islands (lichens, bryophytes, and fungi): New records, threats, and potential as bioindicators – a first evaluation

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Introduction

Lichens, fungi, and bryophytes are frequently referred to as *lower plants*, *non-vascular plants*, or *cryptogams*. All terms are partially incorrect but used for convenience. Strictly speaking only bryophytes are plants. Although lacking conductive tissues, they are photosynthetic. Fungi are not photosynthetic, typically penetrating their substrate as threads of cells. Lichens are fungi in close association with algae. Their algae photosynthesize, supplying the fungus with nutrients, while the fungus provides the structural component.

A) ***Graphis subchrysocarpa***, a crustose lichen with reddish fruiting bodies.

B) ***Bryopteris filicina***, a characteristic liverwort of the humid highlands.

C) ***Podaxis pistillaris***, a characteristic species of dry Galapagos lowlands.

Cryptogams are a diverse group (Figure 1) present in all terrestrial Galapagos ecosystems and dominant in some vegetation zones. Coastal lava is covered by thick crusted lichens that cause weathering. In the dry zone, trees are encrusted with lichens - a protective layer against overheating. In

the transition zone, pale green lichens droop from branches, collecting mist and rainfall. Moss and liverwort carpets drape trees throughout the humid zone in the highlands, collecting the fine mist (garúa) that occurs duing the dry season and producing drip pools on the forest floor. In the humid highlands, *Sphagnum bogs* and lichen heaths are locally common.

Fungi are crucial for soil fertility. They disintegrate organic litter or live within plant roots enhancing nutrient supply. Other fungi are pathogens, and their potential as biocontrol agents is being investigated for blackberry (*Rubus niveus*) and lantana (*Lantana camara*), two of the more aggressive invasive species.

Despite their importance and abundance, Galapagos cryptogams have been neglected in the past. Very few studies document which species are known, rare, or threatened. Their potential as bioindicators has been ignored and their distribution and ecological requirements remain largely unknown. Without this information, understanding of terrestrial ecology is at best fragmentary.

Baseline inventory

Lichen inventories date back to the 1960s (Weber, 1966; Weber & Gradstein, 1984; Weber *et al.*, 1977), culminating in a preliminary checklist (Weber, 1986) with brief updates (Elix & McCarthy, 1998; Weber, 1993). Weber (1966) also published the first checklist of bryophytes, which has been updated (Gradstein & Weber, 1982; Weber, 1976). Reports of macrofungi date back to Darwin (Berkeley, 1842). Subsequent reports are scattered (Bonar, 1939; Evans, 1916; Martin, 1948), with the most current checklist published by Reid *et al.* (1981). Recent surveys have significantly increased our knowledge (Figure 2).

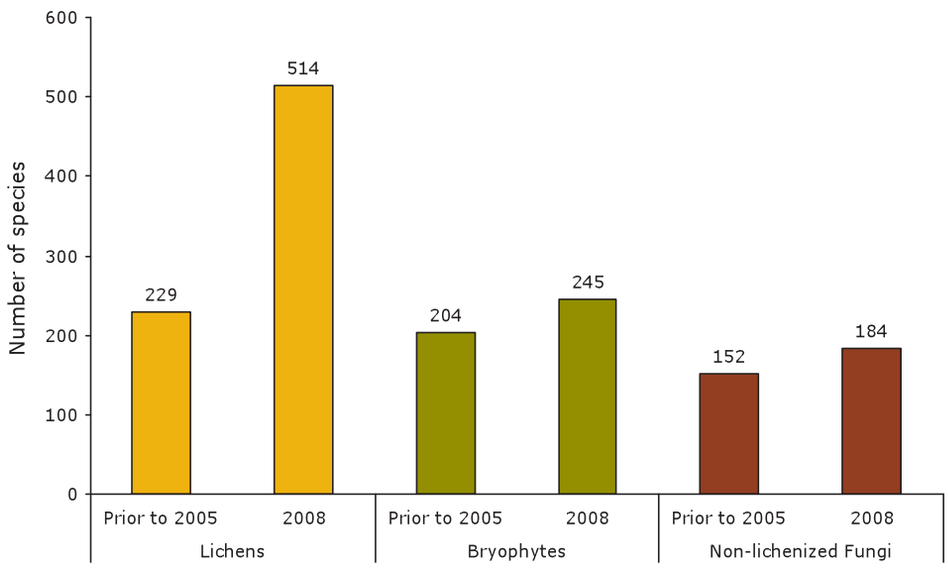

Figure 2. Number of species of Galapagos non-vascular plants (lichens, bryophytes, and fungi) from publications prior to 2005 and current total records (including both records prior to 2005 and from recent surveys).

From December 2005 to January 2008, lichens and bryophytes were collected on Bartolomé, Gordon Rock, Isabela (Sierra Negra, Volcán Alcedo, Volcán Darwin), Pinta, Pinzón, Plaza Norte, Plaza Sur, Rábida, San Cristóbal, Santa Cruz, Santa Fe, and Santiago (Figure 3). A few previous collections are available from Bainbridge Rock No. 6, Daphne Major, Española, Fernandina, Floreana, Seymour Norte, and Wolf. Due to their high dispersal capabilities, the inventory of fungi has been restricted to Santa Cruz. In total, ca. 9000 specimens are now deposited at the Charles Darwin Research Station.

Figure 3. Islands visited during the 2005-08 species inventory of lichens, fungi, and bryophytes.

The large islands have a much wider range of vegetation zones and support higher diversity (Figure 4); however, data must be interpreted with caution as Santa Cruz has been more intensively studied than the other islands.

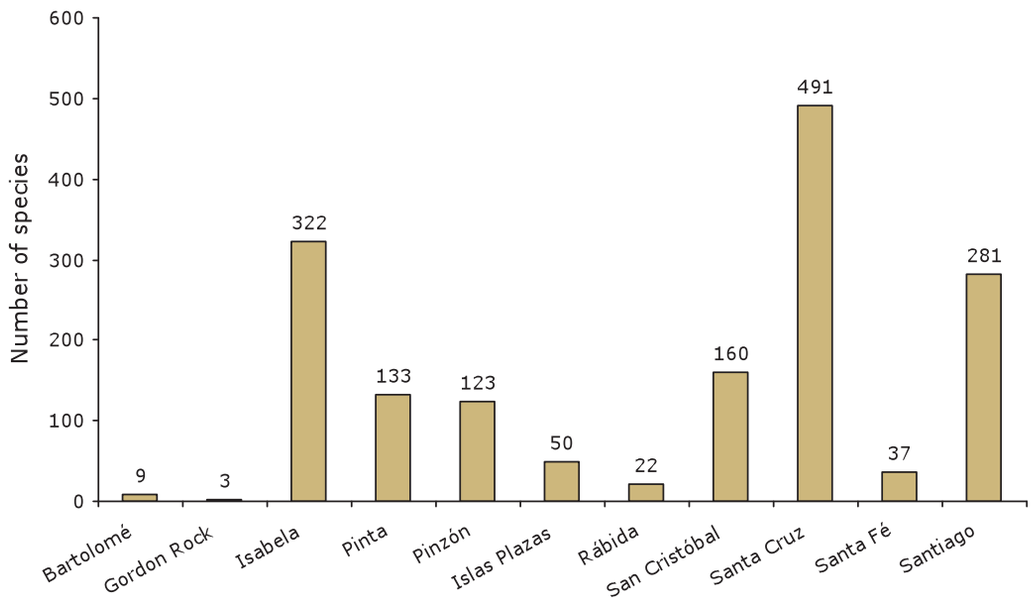

Figure 4. Number of non-vascular plant species (excluding non-lichenized fungi) collected in Galapagos during the 2005-08 inventory.

Most specimens are preliminarily identified (Figure 5). Taxonomic revisions have been published or submitted for: Collemataceae (five records new to Galapagos; Bungartz, 2008), *Ramalina* (four species new to science, nine new records; Aptroot & Bungartz, 2007), crustose Roccellaceae (two species new to science, twenty new records; Aptroot & Sparrius, 2008), *Roccella* (one species new to science;

Tehler *et al.*, 2008), and Graphidaceae (four species new to science, 23 new records; Bungartz *et al.*, 2008).

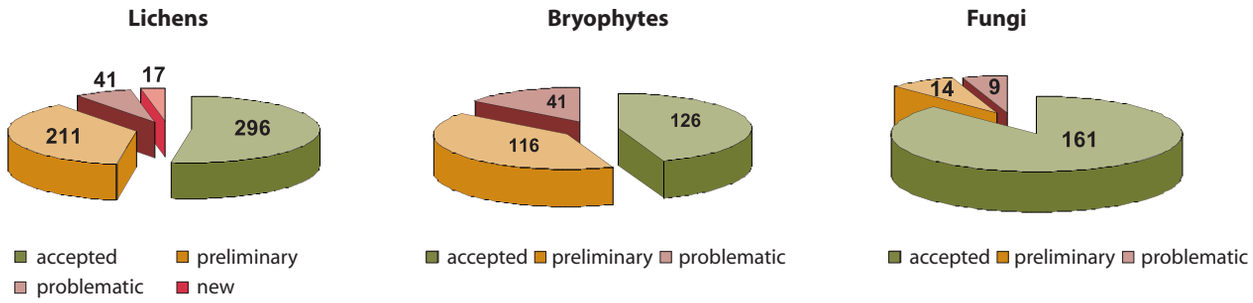

Figure 5. Number of species identifications of herbarium specimens by identification status: a) lichens, b) bryophytes, and c) fungi. Accepted = confirmed using literature and chemical and microscopic analysis. Preliminary = requiring further studies. Problematic = identification does not concur in all aspects with literature references. New = species new to science, either published, or publication in progress.

Though species are generally distributed throughout all habitats, lichen diversity appears highest within the humid zone, followed by the transition, dry, and coastal zones (Figure 6). Again, these figures must be treated with caution. In the humid zone, diversity is disproportionably higher. Because of anthropogenic disturbance, agricultural areas now include species adapted to open habitat originally typical for drier zones.

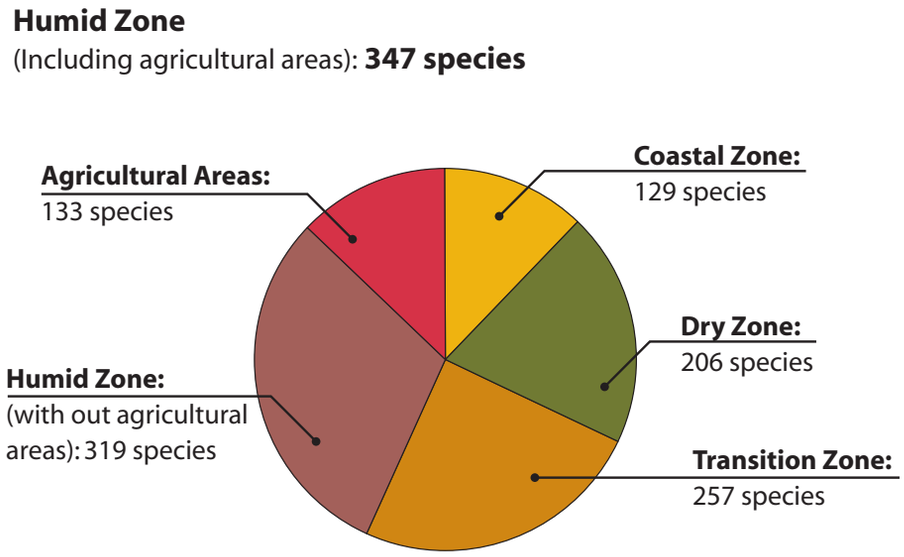

Figura 7. Species diversity of lichens according to Galapagos vegetation zones. Note: there are species that are distributed both in the humid and agricultural zone.

A preliminary estimate suggests that approximately 8-10% of all lichens are endemic, mostly in the coastal and dry zone. Despite lack of historical data, the majority of species is considered native, although preliminary studies indicate higher affinities for some epiphyte species to introduced trees (Nugra-Salazar, 2008).

Both diversity and abundance of bryophytes is highest in the humid zone. Very few species are naturally adapted to dry, open habitat and less than 4% are believed endemic.

Fungi are the least studied group (Arturo-López, 2008) and the existing data do not allow comparison across different zones. The increase of known species (Figure 2) can be attributed to a recent survey of Agaricales (Arturo-López, 2008) and collections of phytopathogenic fungi.

Potential as bioindicators

Lichens and bryophytes obtain water and nutrients directly from the air. They are slow-growing, adapted to mature habitat with high ecological continuity, and sensitive to environmental change. Both groups have been used in other parts of the world as indicators of air pollution, forest health, and climate change (Gries, 1996; Nash & Wirth 1988; Rose, 1976; Rose, 1992; Rose & Wolseley, 1984).

Climate change has the potential to create greater weather extremes, with prolonged and more intense droughts and increasing frequency of El Niño events. If these changes occur, effects should be most pronounced for the following potential bioindicators:

1) Coastal and Arid Zones: lichens on twigs and branches, in particular *Ramalina spp.*

2) Transition Zone: pendulous species contributing to the natural water supply (e.g., *Ramalina* spp., *Usnea* spp., *Teloschistes chrysophthalmus*); some rare species (e.g., *Lobaria dissecta*).

3) Humid Highlands: species that rely on high humidity (lichens: *Leptogium*, *Pseudocyphellaria*, *Coccocarpia*, *Acantholichen*, *Dictyonema*; bryophytes: *Frullania*, *Bryopteris*).

Species rarity and conservation

The considerable increase in known species results from more comprehensive surveys and improved taxonomy. Despite intense surveys, five historically documented species were not relocated and a disproportionately high number is considered extremely rare or rare (Figure 7). The observations are alarming. Potential causes include:

Habitat fragmentation and disturbance: on inhabited islands natural forests have been considerably altered by agricultural land use.

Forest degradation from introduced herbivores: e.g., the destruction of vegetation on Santiago and Volcán Alcedo by goats.

Climatic effects: Weber & Beck (1985) observed drastic population collapses for some species whereas some common bryophyte species became much more abundant after the 1982-83 El Niño; Galapagos species should be adapted to these events but re-establishment has been slow. The cumulative effects of disturbance, habitat degradation, and climate change may have delayed recovery.

Invasive species control: herbicides (e.g., at Los Gemelos on Santa Cruz) are detrimental to cryptogam diversity (Arturo-López, 2008; Nugra-Salazar, 2008).

Restoration of native vegetation: recovery is a slow process; within young forests epiphytes have not yet re-established; the reservoir of rare species may be insufficient for a rapid recovery, which may only occur over the long term.

Locally problematic areas include:

Trash burning at the waste deposit at km 27 on Santa Cruz causes air pollution on a local scale; in the immediate vicinity lichens and bryophytes are no longer present, resulting in a "*cryptogam desert.*"

The cinder cone above Mina Granillo Rojo on Santa Cruz is the only known site for some extremely rare species. This part of the transition zone is characterized by exceptionally high diversity; the open quarry already contributes to dust contamination and habitat destruction; further expansion will have a detrimental impact.

Photograph: Frank Bungartz

Recommendations

A series of recommendations have resulted from this study. These include:

Complete the species inventories; expand the fungal inventory to include all vegetation zones of Santa Cruz.

Monitor recovery following goat eradication on Santiago, Volcán Alcedo, and Pinta; identify species that recover rapidly vs. ones that recover slowly.

Monitor long-term effects from climate change and El Niño events, with particular emphasis on disturbed sites.

Investigate the effects of eradication and control regimes for invasive plant species on the cryptogam vegetation.

Monitor population recovery during restoration of native vegetation.

Abolish or minimize trash burning.

Reduce and restrict mining to areas of low species diversity (e.g., alternative sites like the Mina Granillo Negro).

Risks associated with maritime routes to and within Galapagos[1]

Charlotte Causton[1], Marnie Campbell[2], Chad Hewitt[2], & Ruth Boada[3]

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Ships provide a transport medium for organisms that could pose a direct risk for Galapagos or a risk due to diseases that they might carry. Marine species may be transported in the hulls and ballast water while invertebrates, disease-vector insects, and vertebrates can travel as stowaways onboard ships or within food products, ornamental plants, or equipment that is being transported (Table 1). Also, some organisms are intentionally carried on board, such as pets or ornamental plants.

Tabla 1. Introduction pathways of invasive species by ships.

Introduction pathway	Organism transported
Ship in general	Reptiles, amphibians, rats, and other vertebrates; terrestrial invertebrates
Hull and anchor locker	Marine invertebrates, algae
Ballast water	Marine invertebrates, algae
Food (including live seafood)	Marine and terrestrial invertebrates, diseases
Ornamental plants and flowers*	Soil invertebrates, snails, aphids, scale insects, ants, disease vectors and the associated diseases
Standing water	Mosquitoes
Pets*	Birds and other vertebrates, diseases
Attraction to lights	Moths and other insects
Cargo, containers, and passenger luggage	Terrestrial invertebrates, reptiles, amphibians, and other vertebrates

*** Intentional introduction**

There is little information regarding species that have been transported to Galapagos in ships due to the fact that inspections have not been obligatory nor have they been carried out systematically (Zapata, 2007). For Galapagos, the most probable vectors for invasive species are international yachts and cargo ships, due to the frequency in which they arrive (approximately 20 and 85 times per year, respectively; Cruz *et al.*, 2007). For ships that travel to Galapagos directly from other countries, there is the additional risk of transporting species that are not yet found in continental Ecuador. In this article, we identify the principal vectors for invasive species associated with maritime routes and provide a few examples of incursions that have occurred in Galapagos.

1 Taken from Cruz *et al.*, 2007.

Transport of marine organisms

Ships are the principal vectors for marine organisms. They can transport communities of species in the hull, the propeller and anchor lockers, on the exposed surfaces of water pipes on ships with a metal hull, and in the ballast water (Carlton, 1989). Species can also be transported as live seafood for consumption.

Currently there are no regular inspections of the hulls of the ships that travel to Galapagos and it is not known if invasive marine organisms are entering the archipelago. However, inspections were carried out for the arrivals of the M/N Discovery in 2006 and 2007. These inspections discovered various barnacles, one bivalve species of the Veneridae family that could have been discarded from the food supplies, and green filamentous algae Chlorphytas (Table 2) (GNPS, 2006).

International ships could potentially introduce diverse marine species because their routes connect the archipelago to different parts of the world, including the Baltic, northeastern and northwestern Atlantic, the Caribbean, the northeastern, southeastern, and southern Pacific, and Australia. Numerous marine species have been introduced to these regions and from these regions to others (Coles *et al.*, 1999; Hewitt, 2002). It is believed that the Caribbean is the greatest potential source of invasive species, followed by the northeastern Atlantic and the northeastern Pacific. All of these regions have an environment that is significantly similar to Galapagos ecosystems, suggesting that invasive species that arrive in Galapagos from these areas have a greater chance for survival and establishment.

Some invasive species with a high probability of being transported to Galapagos are: the sea star *Asterias amurensis*; the barnacle *Chthamalus proteus*; the mollusk *Mytilopsis sallei*, and the alga *Undaria pinnatifida*. Characteristics common to all of these species include colonization at high densities, modification of native communities, and potential to cause extensive and costly damage to marine equipment, ships, and the mariculture (NIMPIS 2002; Global Invasive Species Database).

Photograph: Mandy Trueman

Transport of terrestrial invertebrates and plants

Terrestrial invertebrates can be transported to and spread throughout Galapagos by being attracted to the lights on ships, in ornamental plants, on pets, in food products or wood, in fresh water containers, or simply as stowaways (Table 1).

The transport of terrestrial invertebrates in ships has not been well documented in Galapagos, although there are a few examples (Table 2). In the first visit of the international cruise ship M/N Discovery, 16 invertebrate species were found without conducting an exhaustive search (Roque-Albelo *et al.*, 2007). Of these, at least 11 insect species and two families are not registered in Galapagos and represent a risk to the islands if they are introduced and become successfully established. The majority of the insects collected were moths (Lepidoptera) found on deck, probably attracted to lights. Although the ship carries out measures to diminish the risk of transporting insects, 58 live individuals and 17 species of insects were found in the third visit of this ship in April 2007 (Azuero *et al.*, 2007).

Table 2. Introduction pathways reported for organisms transported to Galapagos in ships.

Introduction Pathway	Type of ship	Transported organisms
Hull	International cruise ship	Marine invertebrates (barnacles and a bivalve of the Veneridae family), green algae Chlorophytas
Attraction to lights	International cruise ships and local tourist boats	Moths (Lepidoptera), flies and mosquitoes (Diptera), wasps and ants (Hymenoptera), scale insects and aphids (Heteroptera), crickets (Orthoptera), lacewings (Neuroptera), beetles (Coleoptera), cockroaches (Blattoidea), wasp parasites (Strepsiptera)
Ornamental plants	International cruise ships, international yachts, local tourist boats	Ants, scale insects, snails, soil invertebrates (millipedes, isopods, wood lice, worms, silver fish)
Intentional introduction	International yacht	Monkey, plants, dogs
Stowaways onboard	Local tourist boats, fishing boats, cargo ships	Rats, cockroaches, ants, wasps, iguanas
Stowaways in luggage	Local tourist boats	Reptiles: lizards
As pets	Cargo ships, international yachts	Cats and dogs

A study carried out in 2002 showed that local tourist boats can also be important dispersal agents for insects between islands, including moths, flies, mosquitoes, wasps, and ants, among others (Roque-Albelo *et al.*, 2006, Roque-Albelo *et al.*, this document). The transfer of endemic Galapagos species between islands by local tourist boats could interfere with normal evolutionary and biogeographical processes, while the transport of aggressive invasive species aids their dispersal, increasing the impact on the archipelago.

Ornamental plants provide an effective medium for transporting terrestrial invertebrates, including ants, fitophagous insects and plant disease vectors, snails, and soil invertebrates. A large number of ships that visit the Galapagos Islands or work in the Galapagos Marine Reserve have live plants onboard. Examples of invertebrate species transported to Galapagos on plants onboard international ships include ants and scale insects (Roque-Albelo *et al.*, 2007; D. Arana, SESA-SICGAL, pers. com.). Invertebrates have also been transported to Galapagos on local tourist boats that travel to continental Ecuador or Panama for general maintenance. In 2006, five invertebrate species were found in potted plants recently bought for local tourist boats (F. Bersosa, CDF, pers. com.). These ornamental plants, in addition to being associated with insects or pathogens, could also pose problems themselves, as they are known to be invasive plants in other parts of the world. Occasionally, visitors to Galapagos have given plants as gifts to members of the local community.

Given their small size, invertebrates can hide in food, in other products taken to the islands, or in standing water, as is the case with mosquitoes (Lounibos, 2002). The abundance and diversity of terrestrial invertebrate species (37 species) found in the permanent traps used on the M/N Discovery indicate that one could encounter invertebrates at any moment (Roque-Albelo *et al.*, 2007). This is especially the case for cargo ships where there is much disorder and the food products are not transported in sealed containers.

Transport of vertebrates

Vertebrates can be transported on ships as stowaways. They can also be intentionally introduced to Galapagos. In addition to being a threat due to the impact that they can have as plague species themselves, they can act as vectors for diseases that could affect both humans and native animals.

In an analysis of the transport of rats to and among the Galapagos Islands in 1991, rats were found on 3 of the 42 local tourist boats (7%), 2 of 7 fishing boats (29%), and 1 cargo ship (Calvopiña, 1991). According to Zapata (2007), there is no compliance with the "Procedure for Fumigation during Maritime Transport from

the Continent to the Province of Galapagos" established in 2005[2] and there is still a need to describe in greater detail the procedures for fumigation and rat extermination for boats. It is known that until recently, some cargo ships used cats to capture rats (D. Arana, SESA-SICGAL, pers. com.).

Other vertebrates that have arrived in Galapagos as stowaways include reptiles. During seasons of high densities of green iguanas (*Iguana iguana*) in Guayaquil, this species has successfully boarded cargo ships, aided by the lack of mechanisms to isolate the ships from possible intrusions (R. Rivera, SESA-SICGAL, pers. com.). There are documented instances of green iguanas being transported to Galapagos (D. Arana, SESA-SICGAL, pers. com.). Meanwhile, a lizard *Eumeces inexpectatus* from the southeastern United Status was discovered in the luggage of a tourist on San Cristóbal (Saavedra, 2006). Although their origin and transport pathways have not been confirmed, some introduced species, such as geckos and the frog *Scinax quinquefasciatus*, could have arrived in Galapagos by ship (Tapia *et al.*, 2000).

There have been cases where travelers on boats have gone onshore illegally with pets, such as dogs and a monkey, and instances when these animals have been given to local residents as gifts (D. Arana, SESA-SICGAL, pers. com.). There are also reports of pigs and other domestic animals being introduced via boats (D. Arana, SESA-SICGAL, pers. com.).

Conclusions and recommendations

Given the scarcity of data it is difficult to conduct a complete analysis of the species transported to and among the Galapagos Islands by ships. However, with the evidence in Galapagos and other countries, it can be shown that ships provide introduction pathways for both invasive marine and terrestrial species. With the current increase in the number of cargo ships and private yachts traveling to and among the Galapagos Islands, the rate of introductions is predicted to increase unless an effective biosecurity system is implemented.

Compared with the damage produced by invasive species and the associated costs, the investment in prevention is low and, as such, the prevention of more introductions via the maritime pathway should be considered high priority. The following measures are recommended as a way of lowering the risk of dispersal of both plants and animals via ships:

1. Update and approve the procedures for the fumigation of boats, based on the recommendations of Zapata (2007), expanding the procedures to cover all of the possible entrance routes for invasive marine and terrestrial species.

2. Provide training sessions on best practices for transportation operators, certified fumigation companies, and inspectors of SESA-SICGAL, among others.

3. Establish a data registry on the movement of ships to and among the Galapagos Islands, including the origin of the ship, its fumigation status, sanitary conditions, and last port of departure.

4. Limit access ports, both on Galapagos and the mainland, with the goal of concentrating and improving the inspection capacities of SESA-SICGAL, at the same time minimizing potential entrance routes for exotic species.

5. Avoid the movement among islands of international ships and other boats not registered in Galapagos.

6. Strengthen the inspection of mediums of transport and cargo and ensure sufficient infrastructure.

7. Design a monitoring system for early detection of invasive marine species and strengthen the monitoring system of invasive terrestrial species.

8. Develop contingency plans for rapid response to the introduction of high risk species.

2 Published in the official register (#0023) of 23 May 2005.

Water resource management: the Pelican Bay watershed

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A watershed is a hydrological term that refers to an area where the water that falls as precipitation flows into a single common point or eventually into a single river, lake, or sea. It is also defined as a physiographic unit consisting of a system of rivers defined by topography. All that lives in the watershed, humans, plants, and animals, are inter-connected with the flow of water.

There are 32 principal watersheds in Santa Cruz, with surface areas ranging from 5 km^2 to 50 km^2 (Figure 1). The majority of the watersheds flow from the summit to the sea. However, there are no permanent rivers, only sporadic streams that flow during the rainy season or during heavy mists or *garúa*.

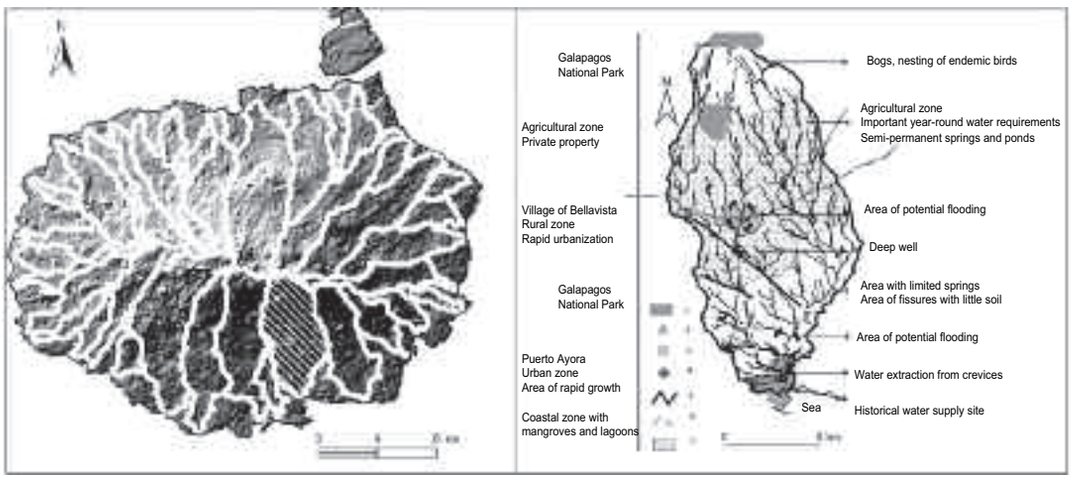

Figure 1. Figure 1. Relief map of Santa Cruz (d"Ozouville *et al.*, 2008b) showing the watersheds with an area greater than 5 km^2 (left); detail of the Pelican Bay watershed (right): 1) hills; 2) old water collection at Cerro Gallita; 3) crevices exploited for water; 4) deep wells; 5) fissures; 6) drainage network; and 7) agricultural zone.

Characteristics of the Pelican Bay watershed

The Pelican Bay watershed covers 43 km^2, extending from the top of Cerro Crocker, the highest point of the island, through the towns of Bellavista and Puerto Ayora, and ending in the sea at Pelican Bay (Figure 1). It is of particu-

lar importance because it includes: (i) protected areas of the Galapagos National Park; (ii) agricultural zones; (iii) rural areas; (iv) urban areas, and (v) the three locations for water extraction by the municipality for supplying the population. During El Niño events, several sections of this watershed flood due to surface water flow. Historically, colonists would obtain brackish water for their needs at Pelican Bay; during El Niño years fresh water springs were observed flowing into the bay. The two meteorological stations in Galapagos with the longest historical records, the Charles Darwin Research Station (CDRS) at 2m above sea level and Bellavista at 194 m above sea level, are both found within this watershed.

Climatic conditions 2007-2008

Analysis of historical meteorological data of the CDF show that the hydrological year in Galapagos runs from June to May. Effective rainfall (that which contributes to recharging the hydrological system) begins with the garúa or cool season (June to December) and is minimal in April and May (d'Ozouville, 2007). The year 2007-08 was characterized by colder than average temperatures during the garúa season and higher than average precipitation during the hot or rainy season. The rainfall of 2007-08 was similar to that of the 1991-92 El Niño. However, oceanic conditions indicating an El Niño event were not recorded in the Pacific. It was, in fact, considered a La Niña.

The higher than average rainfall during the hot or rainy season of 2007-08 was related to the presence of warm surface water that extended from the coast of Ecuador to Galapagos. These warm waters caused excessive precipitation and flooding in continental Ecuador. An understanding of the climate and its high annual variability is fundamental to watershed management because water demands by humans are based on their needs and not the natural limits of the resource, while water demands of the agricultural sector actually increase during years of low rainfall.

Current use of water resources

Water is extracted from the basal aquifer (d'Ozouville *et al.*, 2008a) that lies under the Pelican Bay watershed at three sites:

1) **The Deep Well.** Located at km 6.5 on the road to Baltra, extraction from the deep well began in 2002 and supplies Bellavista and the surrounding areas with water. The water is taken from the basal aquifer at a depth of 158 m. The salt content is less than 1 g/l and there is no evidence of contamination by fecal coliform (information supplied by Galapagos National Park Service (GNPS) and the Japanese International Cooperation Agency (JICA)). The deep well has a high risk of contamination due to its location close to the highway, the suburbs that are growing around it, and the potential for salt intrusion.

2) **The Mission Crevice**. Located at the center of Puerto Ayora behind the Colegio San Francisco, this water source has been exploited since the 1980s and provides water to various sections of Puerto Ayora. It has salt levels higher than 2 g/l and a high level of contamination by fecal coliform (information supplied by the municipality of Santa Cruz and INGALA *et al.*, 1989). This crevice has a high risk of contamination due to the high population density surrounding it.

3) **Pampas Coloradas Crevice.** Located on the road to Baltra in front of the gas station of PetroComercial and the Pampas Coloradas soccer stadium, this crevice has been exploited since the 1980s and provides water to sections of Puerto Ayora. It is also known as the INGALA Crevice. Its salt content is approximately 1.5 g/l and there is contamination by fecal coliform (information supplied by the municipality of Santa Cruz and INGALA *et al.*, 1989). This water source has a high risk of contamination due to its proximity to PetroComercial and the Electric Plant.

Monitoring data of these water sources are scarce. There are no historical records of the variations in the water table, the

volumes of water extracted, or water consumption. In October 2003, a system was established to measure the water table (d'Ozouville, 2007). In November 2007, a system to measure both water extraction and use of these three sources was initiated. This article presents the first data on the status of the extraction and use of water resources from the basal aquifer of the Pelican Bay watershed.

Extraction of water from the deep well and water use in Bellavista

The deep well is exploited through pumping. Each day the pumping hours, the flow rate, and the volume of water pumped are recorded.

The cost of water production (extraction, treatment, distribution, etc.) for the municipality is approximately US$3/m^3 (Delio Sarango, GMSC, pers. com.). The cost of well water for the consumer, which is subsidized by the municipality, is US$1.21/m^3 (1 m^3 = 1000 liters). The water extracted from the well supplies the houses in Bellavista and the surrounding area. Each house has a water meter. The municipal records of water payments permit a calculation of the volume of water used by customers of the deep well.

The average flow from the pump is 8.9 l/s. This value is greater than the tested limit of the pump (6 l/s) and the rate recommended to ensure that intrusion of sea water and contamination of the well do not occur (Proctor and Redfern Int. Ltd., 2003). However, the pump is never run for a full 24-hour period (generally from 0 to 18 hours). The volume of water extracted per day for the days when the pump is operating varies between 88 and 195 m^3 (Figure 2).

The monthly extraction rate from November 2007 to May 2008 ranged from 2734 m^3 to 6053 m^3, while the volume consumed ranged from 2222 m^3 to 4335 m^3 (Figure 2). In both cases, the lowest amount was recorded in March when precipitation was highest. These data suggest that some residents of the highlands collect rainwater and do not use well water while they can collect rainwater. Although precipitation remained high in April, the same tendency was not observed, because the precipitation came in two very heavy downpours, which did not permit storing sufficient water for the month.

Two key points arise from these data:

1) There is a loss of water between extraction and use. All of the water extracted from the deep well supplies Bellavista and the surrounding neighborhoods, so all of the water should pass through the water meters of the houses. Therefore, the amount extracted should equal the amount consumed. Between November 2007 and May 2008, between 500 m^3 and 2800 m^3 of water extracted from the well were not accounted for, which represents a monthly revenue loss between US$605 and US$3388 for the municipality of Santa Cruz.

While loss from leakage is assumed to be common, it would tend to be constant over a long period of time. Leakage should not equal more than 500 m^3, the minimum volume recorded as "lost" in November and March. In the other months, the volume lost represents up to 40% of the volume extracted, taking into account a fixed loss due to leakage of 500 m^3. This loss must be accounted for by some other explanation, such as unauthorized water connections. The reduction in unauthorized connections in November and March can be explained by the abundant rainfall providing a sufficient natural supply of water.

2) Based on the water use data and the population census (1608 inhabitants; INEC, 2007), water consumption in Bellavista and the surrounding areas is between 45 and 87 l/person/day. This volume is very acceptable when compared with domestic water use worldwide[1].

1 The FAO (Food and Agriculture Organization) recommends a minimum value for domestic water use at 50 l/person/day, which includes 2 to 5 l for drinking, 20 l for sanitation, washing clothes, etc.; 15 l for bathing, and 10 l for cooking. In developing countries the value ranges from 60 to 150 l/person/day. In developed countries the range is between 300 and 800 l/person/day.

However, three points are important to consider: 1) inhabitants also collect rainwater; 2) data are lacking regarding the collection of rainwater; and 3) unauthorized connections are not taken into account.

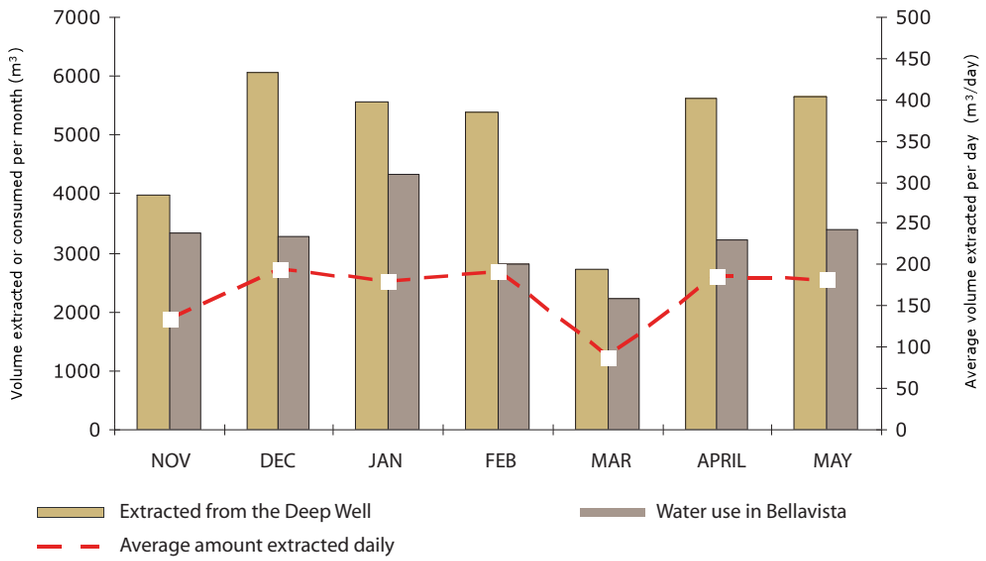

Figure 2. Monthly volumes of water extracted from the Deep Well and used in Bellavista from November 2007 to May 2008 and the average amount extracted per day. Source: Municipality of Santa Cruz.

The volumes of water extracted from the crevices in Puerto Ayora were calculated based on the flow rate and operation times for each pump (Table 1). There are no daily records for the pumps, so the data represent an average based on typical hours of operation.

Table 1. Estimated water flow rates from the crevices located in Puerto Ayora. Source: Municipality of Santa Cruz.

	Flow rate (Q) (l/s)	Hours of Operation	No. Hours	Average daily volume (m^3/day)
Mission Crevice				
Pump #1	22	7h00 - 18h00	11	871.2
Pump #2	12	7h00 - 16h00	9	388.8
Pampas Coloradas (INGALA) Crevice				
Pump #1	15	6h30 - 18h00	11.5	621
Pump #2	15	6h30 - 18h00	11.5	621
Pump #3	30	6h30 - 18h00	11.5	1242
Pump #4	18	6h30 - 16h30	10	648
Pump #5	18	6h30 - 16h30	10	648
Total (m^3/day)				**5040**

The average daily volume of water extracted from the Mission and Pampas Coloradas crevices is 5040 m^3/day. This water is complemented by six water systems used by businesses or institutions. These systems are not registered at the municipality and could be significant: S. Amy; Tesalia; Finch Bay; M. Gallardo; M. Schrier; Charles Darwin Research Station, and other private users, for example the water supply for houses on Punta Estrada.

There are no data on water use in Puerto Ayora. The houses do not have meters and the users pay a fixed monthly

rate based on their category of use (Table 2). This represents a monthly revenue of US$14 000 for the municipality to cover a portion of the costs of production and maintenance of the network and equipment.

Table 2. Water rates and revenues by category in Puerto Ayora. Source: Municipality of Santa Cruz.

Municipal categories for water rates	Monthly water rate (US$)	No. Registered	Monthly municipal revenue (US$)
Domestic	5.00	1298	6490
Official	6.00	24	144
Commercial	11.00	563	6193
Swimming pool	28.00	2	56
Industrial Residential	28.00	7	196
Industrial Hotel	45.00	13	585
Industrial Laundromat	45.00	6	270
Industrial Water Production	45.00	2	90
TOTAL		**1915**	**14024**

In November 2007, 13 water meters were installed in both homes and businesses in Puerto Ayora to obtain quantitative data on the average water use for the various categories of consumers. Data were obtained through the middle of December 2007. At that time the meters were discontinued because the consumers complained that the meters caused a drop in their water pressure. Between 10 November and 10 December, while the meters were functioning, the average monthly water use of houses was 87 m^3, with a range of 10-170 m^3 (Figure 3). The water use was much higher than the monthly average in Bellavista (13.5 m^3). Water use in the other categories was also highly variable.

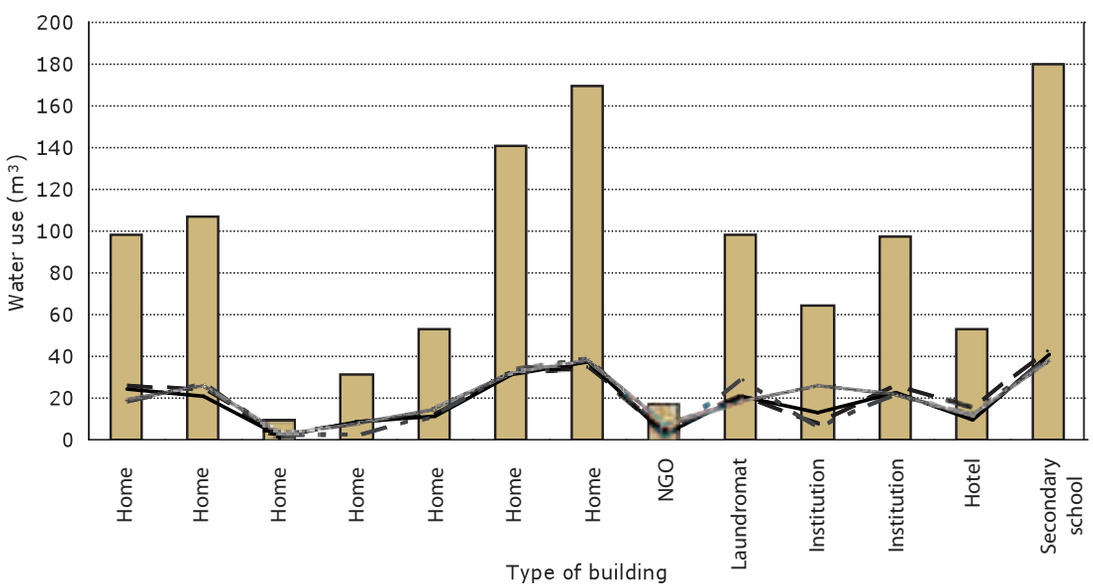

Figure 3. Water use in Puerto Ayora recorded by water meters in November/December 2007. Source: Municipality of Santa Cruz.

Water use per person per day in Puerto Ayora was calculated using two methods:

1) Assuming an average of 3.5 persons per house in Puerto Ayora (INEC, 2007), the data from the water meters results in a water use ranging from 92 to 1567 l/person/day, with an average of 802 l/person/day. The high variability demonstrates the importance of

obtaining more data to identify existing problems.

2) Using the volume of water extracted from the basal aquifer and census data for the population (9163 inhabitants in Puerto Ayora; INEC, 2007), water use is 550 l/person/day. This value is lower than the average resulting from the meters, but confirms that there is an unmeasured water use in Puerto Ayora that must be explained and corrected.

Various points must be taken into account in relation to these data:

1) INEC census data may underestimate the actual population size.

2) There is a significant floating population in this town due to tourism, which is not accounted for in water usage.

3) The rate of leakage is important.

4) There is a high level of water loss when pumps are left on after the tanks are filled.

5) Changes in lifestyle (bathtubs, swimming pools) are resulting in increased use.

6) There has been a significant increase in construction in recent years.

To provide one example, the average daily volume of water that is carried by tanker truck to supply tourist boats, farms in the highlands, and others is estimated at 167 m^3. If this is subtracted from the total, the water use per person per day in Puerto Ayora decreases to 530 l/person/day.

These data indicate that the extraction of water from the basal aquifer is excessive based on the calculated requirements and that it is indispensable to acquire additional information in order to answer the following questions:

1) What is the volume of water extracted for commercial, institutional, and private use that is independent of the municipal water delivery system?

2) What is the distribution of the water carried by tanker trucks by sector?

3) What is the distribution of water among the different sectors (industrial, commercial, agricultural, tourism, and domestic)?

4) What is the actual population in the Puerto Ayora/Bellavista area, considering illegal residents, floating population, etc. ?

Conclusions and recommendations

The hydrological balance can be calculated for each watershed. In the case of the Pelican Bay watershed, the rate of recharge by infiltration of effective precipitation to the subterranean system is estimated at 8 million m^3/year, while the current data indicate an extraction rate of 1.9 million m^3/year. Although the extraction rate is lower than the recharging rate, the hydrodynamic and geochemical characteristics of this watershed indicate that the basal aquifer has a low volume of fresh water and that it is in a fragile equilibrium with the sea. In addition, the amount of precipitation entering the system on an annual basis is highly variable due to the climatic variability of Galapagos, whereas the demand for water continues to increase. Climatic data are critical to understanding the dynamics of the water resource and its availability over time.

The 2007-08 hydrological year demonstrated the unpredictable nature of the Galapagos climate. It is critical that a larger monitoring network be established to understand the complexities of the hydrological system and to better prepare for any effects of climate change. In addition, this study identified two serious problems associated with the Pelican Bay watershed and the use of subterranean water: (i) high volumes of water have not been

Photograph: Verónica Toral

accounted for, as observed at the Deep Well, and (ii) the average use in Puerto Ayora appears to be much greater than the amount recommended on an international scale. Currently, the initiation of a comprehensive metering system for water use in Santa Cruz is of great importance for decision-makers, as this is the only way to identify trends in water use and to have access to the information needed to make decisions regarding water resource management.

To improve the use of the limited water resource, the following measures are recommended:

1) Provide training for institutions in the recording, analysis, and proactive use of water data. For example, the municipality should work to identify the source of discrepancies between the rates of extraction and use in Bellavista.

2) Expand the metering system to obtain quantitative data of the volume of water used by each sector: tourism, agriculture, industry (construction, laundromats, etc.), and commercial.

3) Implement payment by volume of water used in Puerto Ayora as currently occurs in Bellavista to provide incentive for better water use practices, lower the average use per person, and increase the revenue received by the municipality for maintenance of the water system and to improve services.

4) Implement regulations, such as floats in tanks, control of water use in swimming pools, limits on watering and irrigation, and incentives for collecting rainwater.

5) Continue to collect data on the extraction of water from the basal aquifer and require that all private water users maintain a monthly record of volume used.

6) Create a working group to implement a strategy for the integrated management of the watersheds.

7) Continue scientific research to determine the exact rate of aquifer recharge and the effects of climatic variability.

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